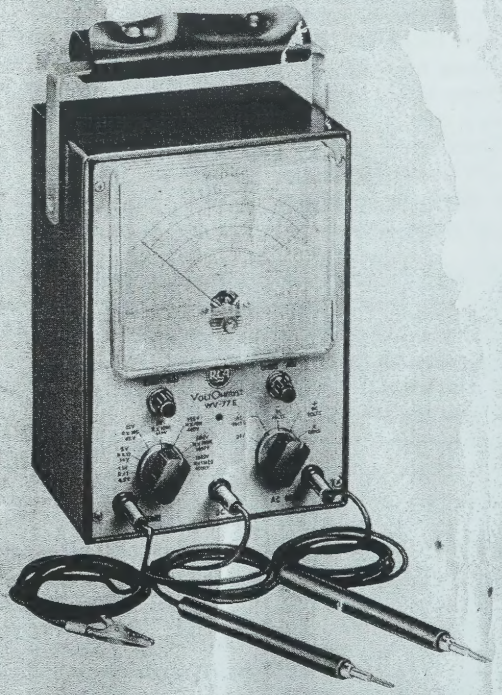
PRICE ONE DOLLAR

RCA

VOLTOHMYST®

Type WV-77E



- Specifications
- Operation
- Maintenance

RADIO CORPORATION of AMERICA
ELECTRON TUBE DIVISION HARRISON, N. J.
(TEST EQUIPMENT, CAMDEN, N. J.)

Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit through a resistance-capacitance network. For proper operation, the ground cable of the WV-77E should always be connected to the ground of the equipment under test, before any other connections are made. Always handle the probes by the molded plastic probe housing.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

Items supplied with the WV-77E

1 DC Probe and Cable
1 AC-Ohms Probe and Cable
1 Ground Cable
1 Instruction Booklet
2 Service Order Forms
1 RCA-12AU7-A
1 RCA-6AL5
1 RCA-VSO35
1 Registration Card

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AC Voltmeter

Ranges:

RMS Values of Sine Waves . { 0 to 1.5 volts on separate scale
0 to 5, 15, 50, 150, 500, 1500 volts

Peak-to-Peak Values of Sine Waves . . . . . { 0 to 4 volts on separate scale
0 to 14, 40, 140, 400, 1400, 4000 volts

Accuracy . . . . . ±5% of full scale

Frequency Response

±5% 40 cps to 5 Mc. On 1.5, 5, 15 rms, or 4, 14, 40, p-p ranges

Maximum Input Voltages

When instrument is set up to measure DC:

DC . . . . . 1500 volts
DC plus AC (peak) . . . . . 1800 volts

When instrument is set up to measure AC:

Maximum AC (rms) . . . . . 1500 volts
Maximum AC (peak-to-peak) . . . . . 4000 volts

NOTE: When AC is being measured, no more than 400 volts DC shall be present in circuit being tested.

Tube Complement 1 RCA-6AL5, 1 RCA-12AU7-A

Power Supply:

Voltage Rating . . . . . 105 to 125 volts
Frequency Rating . . . . . 50 to 60 cps

Battery:

1.5-volt cell RCA-VSO35

Mechanical

Dimensions: (less handle)

Height . . . . . 7¾ inches
Width . . . . . 5⅝ inches
Depth . . . . . 4¾ inches
Weight . . . . . 5 pounds

RCA Repair Service

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Information furnished by RCA is believed to be accurate and reliable. However, no responsibility is assumed by RCA for its use; nor for any infringements of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of RCA.

General Description

The VoltOhmyst®* WV-77E is designed to measure ac rms values of sine-wave voltages from 0.1 to 1500 volts, dc voltages from 0.02 volt to 1500 volts, peak-to-peak voltages from 0.2 volt to 4000 volts, and resistance values from 0.2 ohm to 1000 megohms. The ac voltmeter portion of the WV-77E features an electron tube as the full-wave signal rectifier. The meter reading in ac-voltage measurements is a function of the full peak-to-peak value of the measured waveform. The WV-77E has a high input impedance on all dc- and ac-voltage ranges. The high impedance input allows the use of the WV-77E in circuits where instruments with a lower input impedance would result in loading of the circuit under test, and a resultant error in reading the operating voltage.

The VoltOhmyst utilizes a push-pull balanced dc-bridge circuit with the meter in the plate circuit. This circuit affords excellent linearity of response, good stability, and very high input impedance. (See Schematic Diagram, Page 14.)

Additional features of the WV-77E include provision for zero-center indication, useful in discriminator and bias measurements; separate scales for low ac-voltage measurements to assure accurate readings; a circuit design which allows measurement of ac in the presence of dc and vice versa; a separate dc probe with a 1-megohm resistor which minimizes capacitance-loading effects; and electronic protection against meter burnout. In addition, the resistors in the resistance divider network are protected by a separate fuse.

The WV-77E VoltOhmyst is a light-weight, compact, versatile instrument. This reliable measuring device will prove extremely useful in television applications as well as in many industrial applications.

Specifications

Electrical

Performance figures are for line voltage of 117 volts, 60 cps.

DC Voltmeter

Ranges . . . . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance with DC probe (1 megohm inside probe)
All Ranges . . . . . 11 megohms
Accuracy . . . . . ±3% of full scale

*TMK® Marca(s) Registrada(s)

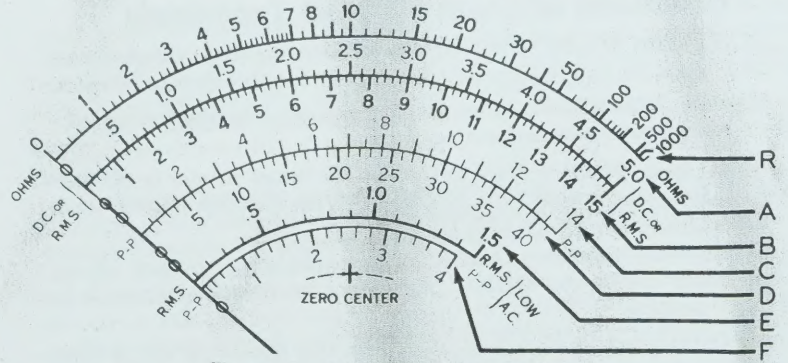

Figure 1. WV-77E Meter Scales

TABLE 1
RESISTANCE MEASUREMENTS

Resistance to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 1000Ω	R X 1	R	1
1000 to 10000Ω	R X 10	R	10
10000 to 100000Ω	R X 100	R	100
100000Ω to 1 MEG	R X 1000	R	1000
1 MEG to 10 MEG	R X 10K	R	10000
10 MEG to 100 MEG	R X 100K	R	100000
100 MEG to 1000 MEG	R X 1 MEG	R	1 MEG

DC-VOLTAGE MEASUREMENTS

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.02 to 1.5V	1.5V	B	0.1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	1
15 to 50V	50V	A	10
50 to 150V	150V	B	10
150 to 500V	500V	A	100
500 to 1500V	1500V	B	100

Resistance readings inaccurate on some or all "ohms" ranges.

1. One or more resistors in network around switch S1, Sect. 2, rear, have changed value. Fuse, F1, has developed a high resistance.
2. Excessive leakage in "ohms" circuit. Check switch wafers on S1 for dirt or damage. NOTE: High humidity after a prolonged idle period may cause leakage and inaccurate readings on high ohms scales. Operate instrument for several hours until thoroughly warm and dry.
3. Poor contact from ground jack to ground bus on chassis.
4. Shorted wiring in resistor network around S1.
5. Faulty or high-resistance connections in "ohms" circuit.

Meter pointer moves off infinity mark when range switch is changed.

1. Replace V2. See "Tube Replacement". NOTE: (A small deviation should be considered acceptable.)
2. Excessive leakage in ohms circuit, possibly caused by high humidity. Allow instrument to operate for several hours until dry.

AC-Voltage Function

Instrument fails to indicate on any ac-voltage range; works normally on OHMS and DC VOLTS.

1. V1 defective. See "Tube Replacement".
2. AC volts contact on switches may be defective.
3. Faulty wiper contact on S1, Sect. 2, front.
4. Open or short circuit in circuitry associated with V1. Check out wiring and components values with ohmmeter.
5. C1 or C2 open, C3 shorted, or R4 open.

Meter pointer moves off zero when ranges are changed.

1. "AC BAL" potentiometer out of adjustment. Readjust as described under "AC Balance Adjustment." If adjustment cannot be made, then replace V1. See "Tube Replacement".
2. Resistor network around S1, Sect. 1, rear, is defective. Check continuity and values with ohmmeter.

AC-voltage readings inaccurate on all ac ranges; performance on ohms and dc-voltage ranges is normal.

1. V1 defective. Install new 6AL5. See "Tube Replacement".
2. Check C1, C2, and C3.
3. R4 changed in value.

If instrument is inaccurate on 500 and 1500 volt ranges only, check R1, R2, R3, and C2. If inaccurate on 1.5 volt range only, replace V1. See "Tube Replacement".

AC and dc-voltage readings inaccurate on some or all ranges; resistance readings correct.

1. Resistor network around switch S1, Sect. 1, rear, defective. Check values with ohmmeter.
2. Defective contacts or wipers on switch S1, Sect. 1, rear. Check for loose or dirty contacts.
3. Excessive leakage in switch S1.

DC-Voltage Function

Instrument fails to indicate on any range of "+VOLTS" or "—VOLTS".

1. DC probe or cable is defective.
2. DC-voltage contacts on switch sections are defective. Check for loose or broken contacts.
3. Check R7 and switch S2, Sect. 1, front.

Instrument fails to indicate on any range of "+VOLTS" but normal on "—VOLTS" or vice versa; works normally on ohms and ac volts.

1. Defective contacts on switch section S2, Sect. 2, front. Check switch for loose or broken contacts.

Voltage readings inaccurate on "+VOLTS", "—VOLTS", or both; ac voltage and resistance readings are correct.

1. R7 out of adjustment. Reset as described under "DC Voltage Calibration".
2. Isolating resistor in probe has changed value. Measure resistance on OHMS function. NOTE: If one or more of the low-value resistors in the network around S1, Sect. 2, rear, have changed value, it is possible that the meter reading may be inaccurate on the 500 and 1500 volt ranges but the inaccuracy may not be apparent on the lower ranges.

DC and AC voltage readings incorrect; resistance readings correct.

1. Resistance in network around S1, Sect. 1, rear, has changed value. Check out with ohmmeter and replace defective resistors.
2. Switch contacts on S1, Sect. 1, rear, defective. Check for loose or broken contacts, or foreign material.

Instrument fails to function on ac and dc voltage measurements; works normally on ohms function.

1. Check S2, Sect. 2, front, and network around S1, Sect. 1, rear.

Functions of Controls and Terminals

FUNCTION SELECTOR — Has two functions; turns the power off in "OFF" position, and permits choice of type of measurement to be made.

RANGE SELECTOR — Permits choice of range for the desired voltage or resistance measurement.

ZERO ADJ control — Used to position the meter pointer to the left-hand "0" and to zero-center the pointer when the function selector is set to either "+VOLTS" or "—VOLTS".

OHMS ADJ control — Used to position the meter pointer at the extreme right line on the "OHMS" scale when the function selector is in "OHMS" position.

AC OHMS jack — blue lead plugs into this connector and is used to measure ac voltage and resistance as described under "Operation" below.

DC jack — red lead plugs into this connector, and is used to measure dc voltage as described under "Operation" below.

GROUND jack — black lead plugs into this connector, and is connected to the ground of the circuit under test for all voltage measurements. This lead is also used for making resistance measurements as described under "Operation" below.

Operation and Applications

Preliminary Adjustments:

To prepare the WV-77E for use, make the following connections and adjustments:

1. Connect the cables to the appropriate front-panel connectors.
2. Plug the power cord into an ac outlet supplying 105-125 volts at 50-60 cps and adjust the controls as follows:

a. Set the function selector to "+DC VOLTS" and allow a few minutes for the instrument to warm up.

b. Adjust the ZERO control to position the meter pointer at the left-hand zero on the scales.

c. Turn the function selector to "R OHMS." The pointer should deflect to approximately full scale.

d. Rotate the OHMS ADJ control to position the pointer at the last line on the "Ohms" scale.

Continued on Page 7

peak values are read from scales marked C and D. Scale E is used for ac measurements up to 1.5 volts. The corresponding peak-to-peak values are read from scale F. The particular scale which is used for any given function is determined by the setting of the range switch.

Table I has been prepared as an aid in selection of ranges, scales, and multiplying factors for all measurements which can be made with the WV-77E.

Because of the wide number of measurement ranges provided on the WV-77E, it is often possible to take voltage or resistance reading on two ranges and scales. For greatest accuracy in voltage measurements, always use the range which will provide an on-scale reading which is nearest to the full-scale point. For example, 48 dc volts can be read from either the 50-volt or the 150-volt range. Because the 50-volt range will provide a reading nearest the full-scale point, the 50-volt range only should be used if a reading of best accuracy is to be obtained. This general rule applies to all ac- and dc-voltage ranges. For ohms measurements, however, the range-selected should be the one which provides a reading nearest the *center* of the scale because the VoltOhmyst provides the most accurate readings at mid-scale points.

For some measurements it will be necessary to use a multiplying factor with the scale reading to obtain the correct reading. The required multiplier is indicated by the setting of the range switch. For example, when the range switch is set to the 500-volt position for a dc-voltage measurement, the "A" scale (Figure 1) is used. Because this scale has a full scale value of "5", it is necessary to multiply any readings on this scale by 100 to obtain the correct value.

Normal Operating Characteristics:

With a high-impedence, high-sensitivity meter, such as the Volt-Ohmyst, it is entirely normal to expect a deflection of the meter pointer when the leads are touched and the meter "Range" switch is in one of the lower voltage positions.

In the AC position, touching the AC probe will cause the meter to deflect, which indicates that your body is in a strong AC field. If you touch the ground lead at the same time, the reading will decrease almost to zero, depending on the resistance of your hand connection, body resistance, and relative strength of the AC field.

In the DC position, touching the DC probe will cause the meter to "kick", but the pointer will return to zero. However, if you hold the DC probe in one hand and hold the ground lead in the other hand, the meter may remain deflected, simply because it is reading the contact or "battery" potential created by your hands in contact with the probe connections which are made of dissimilar metal. Try holding a nickel (5-cent coin) in each hand, and then touch the probe and ground lead with the coins—now the pointer deflects very little.

divider networks. Excessive heating may permanently change the value of the resistors and result in inaccurate meter readings. A pair of long-nose pliers may be clamped to the lead between the resistor being soldered and the point of connection to dissipate as much heat as possible. Care should also be taken to prevent twisting or loosening of the switch contacts and to prevent solder from getting down into the switch. Contacts may be cleaned with cigarette-lighter fluid.

General

Meter pointer moves off zero ("0") when Range Switch is moved from one range to another, or when Function Switch is shifted from "—DC VOLTS" to "+DC VOLTS".

1. This type of trouble is usually caused by condensed surface moisture which is accumulated during periods of non-usage in humid weather. The trouble will correct itself after the instrument is turned "ON" for a few hours—the heat from the tubes and the transformer will evaporate the moisture.

Instrument fails to operate on all functions; tubes do not light.

1. Line cord broken or not making contact at outlet.
2. Switch S2 Sect. 1, rear, defective.
3. T1 defective. Check continuity of windings and resistance to ground.

Instrument fails to operate on all functions; tubes light, ZERO ADJ does not work.

1. Broken lead in ground cable or common jack defective.
2. Incorrect operating voltages on 12AU7-A bridge tube. Measure tube and power supply voltages with voltmeter.
3. V2 defective. Replace as described under section "Tube Replacement."
4. Open or short circuit in V2 bridge circuit. Check out with ohmmeter. Check each component, especially R10, R11, R12, C6, T1 secondary, and meter leads.
5. Check switch S2.
6. CR-1 defective.

Meter pointer sticks.

1. Cracked or broken jewel bearing in meter. NOTE: Individual replacement parts for meter movement are not available. Meter should be returned for repairs or replaced with new meter.
2. Scale plate on meter is loose and is striking pointer. Remove meter from meter case and tighten mounting screws.

Meter pointer moves sluggishly; slow return to zero point.

1. Anti-static solution on inside of plastic meter window is no longer effective. Recoat with solution. See section on "Zero Setting of Pointer".

Meter pointer bangs hard left or right, depending upon setting of function switch.

1. Open or short circuit in bridge circuit.

Intermittent operation on all functions.

1. Loose or broken connections in cables. Check by flexing cables and observing meter readings.
2. Poor ground connection between ground jack and ground bus of chassis. Check lead to R35.
3. Wiper contacts on S2 defective.
4. Loose or broken connection in bridge circuit wiring or components, including meter terminals. With power applied, probe wiring, connections, and components with insulated probe. CAUTION: See "Safety Precautions", page 2.
5. Loose or defective component in power supply.
6. V2 defective. Replace tube as described under "Tube Replacement".

ZERO ADJ control erratic in operation.

1. Potentiometer R11 defective. Replace with new control. NOTE: First, make sure mechanical zero of meter pointer is correct. See "Zero Setting of Pointer".

Ohms Function

Instrument fails to indicate on OHMS; works normally on ac and dc voltage measurements.

1. Battery exhausted or not making contact.
2. Fuse F1 open. To replace fuse, clip leads at point of contact with end cups. Hold with pliers, and solder new fuse to stub ends of leads.
3. Loose or broken connection in ohms cable. Check by flexing cable and observing meter reading.
4. Defective wiper contact on switch S1, Sect. 2, rear.
5. "Ohms" contact (terminal 11) on S2, Sect. 2, front defective.
6. OHMS jack, or lead open or shorted to other wiring or to instrument. Check resistance to case and adjacent wiring.
7. Cable connector not making contact.

OHMS ADJ fails to give infinity setting on "R" scale.

1. Battery exhausted.
2. OHMS ADJ potentiometer, R8, defective.
3. S2 defective.

AC RMS VOLTAGE MEASUREMENTS

RMS voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.1 to 1.5V	1.5V	E	1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	1
15 to 50V	50V	A	10
50 to 150V	150V	B	10
150 to 500V	500V	A	100
500 to 1500V	1500V	B	100

AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS

Peak-to-peak voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 4V	4V	F	1
4 to 14V	14V	C	1
14 to 40V	40V	D	1
40 to 140V	140V	C	10
140 to 400V	400V	D	10
400 to 1400V	1400V	C	10
1400 to 4200V	4000V	D	100

(Continued from Page 5)

e. Turn the function selector to the "AC" position, and set the range switch to the "1.5V" position. The pointer should deflect back to the left-hand zero. The instrument is now ready for use.

Use of Range and Meter Scales:

The meter scales on the WV-77E have been designed to provide ease of operation and quick readability over a wide range of measurements. Scales have been grouped according to the type of measurement for which they are used. The "Ohms" scale, at the top of the scale plate, is used only for resistance measurements, and all resistance measurements are read from this one scale. All dc voltages are read from the two scales marked "A" and "B" in Figure 1. The rms values of sine-wave voltages are also read from scales marked A and B. The corresponding peak-to-

When making dc-voltage measurements, the DC Probe should be used.

The WV-77E has seven dc-voltage ranges from 0 to 1.5, 5, 15, 50, 150, 500, and 1500 volts. Although the meter is protected against burnout, it is good practice to make a trial measurement at a higher range setting than is considered necessary, because long-continued or repeated overload of the meter movement may eventually impair the accuracy of indication.

To measure dc voltages, proceed as outlined below:

1. Set the function selector to "+VOLTS" or to "−VOLTS" as required.
2. Connect the Ground Cable clip to ground.
   CAUTION: See first paragraph of "Safety Precautions" on page 2.
3. Set the range selector to a position considerably higher than the voltage to be measured.
4. Touch or connect the DC Probe to the high side of the source voltage.
5. Reset the range selector to a position which gives a suitable pointer deflection.
6. Read the dc voltage from the scale corresponding to the range-selector setting. See Table 1.

Zero-Center Indication:

Zero-center indication is frequently useful because it allows observation of either positive or negative dc-voltage excursions without the necessity of resetting the function selector.

1. Set the function selector to "+VOLTS".
2. Rotate the ZERO ADJ control to position the pointer at the center " " zero center. If the ZERO ADJ control does not have sufficient range to move the pointer to the zero center position, switch the function selector to "−VOLTS".
3. Make a test reading and then reset the range selector to the lowest position which allows the pointer to remain on the scale.

AC-Voltage Measurements:

CAUTION: See Maximum Input Voltages, under "Specifications". The AC probe should be used for all ac-voltage measurements.

1. Set the function selector to the "AC VOLTS" position.
2. Set the range selector to a position higher than the voltage to be measured.
3. Adjust the ZERO ADJ control if necessary to position the meter pointer at the left-hand "0". Ground the ac probe when making this adjustment on the 1.5 and 5.0 volt ranges.
4. Connect the ground clip to the ground of the circuit under test.
5. Touch or connect the ac probe to the high side of the source voltage.
6. Read the ac voltage from the scale corresponding to the range-selector setting. See Table 1.

necessity for this readjustment can be minimized by checking the battery and installing a 12AU7-A tube. Refer to Tube Replacement section.

RCA Repair Service

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Trouble-Shooting the WV-77E

Circuit Description

The operation of the WV-77E centers around a vacuum-tube bridge circuit. The bridge circuit is composed of the two triode units of an RCA-12AU7-A. When the two sections of the bridge are balanced, there is no voltage difference between the two plates, therefore, the meter which is connected between the plates reads zero. The ZERO ADJ control is used to adjust the plate load resistor so that the two sections of the 12AU7-A are balanced.

When a positive voltage is applied to the grid of V2A, the current flowing through this unit of the tube increases, causing the plate voltage of V2A to decrease. This current also flows through resistor R-15, which is common to both V2A and V2B, increasing the voltage drop across the resistor and biasing V2B in a negative direction. This bias voltage decreases the plate current, causing the plate voltage of V2B to increase. As a result, the current flows through the meter from V2B to V2A. Since this current is directly proportional to the applied voltage, the calibrated meter indicates the applied voltage.

When the WV-77E is used to measure ac voltage, the voltage is first rectified by an RCA-6AL5 twin diode ac-signal rectifier. The circuit is designed so that the voltage developed by one-half of the ac cycle is added to the voltage developed by the other half of the ac cycle. The dc voltage thus developed is the peak-to-peak value of the applied ac

voltage. This dc voltage is then applied to the grid of V2A through a voltage divider and the bridge-circuit operates as described above.

With the ac-signal rectifier, 6AL5, in the circuit, a difference in the materials used in the plate and cathode may cause a small voltage to appear at the input to the bridge circuit. This voltage, called contact potential, would cause a slight meter deflection. In the WV-77E, a small voltage (bucking voltage) of opposite polarity is fed back to cancel the contact potential. The required value of this bucking voltage is adjusted by means of the AC BAL control, R-18.

A flashlight battery inside the instrument is used to provide a dc voltage for resistance measurements. This voltage is applied through the ohms divider-network to the grid of V2A. The voltage applied to the grid causes the meter pointer to deflect to full scale. When a resistor is connected between the ohms probe and the ground probe, the resistor is in series with the ohms divider-network. The battery voltage is divided between the internal network and the external unknown resistance. Therefore, a smaller voltage appears at the grid of V2A causing a right-to-left deflection of the meter pointer. The WV-77E incorporates a fuse in the ohms circuit to prevent damage to the resistors in the divider network.

Maintenance

The WV-77E is a relatively simple instrument. Troubles which develop may usually be analyzed without difficulty. Check the instrument on all ranges and on all functions before attempting any repairs. Examination of the schematic diagram will show that the voltage divider network used for resistance measurements is not used when making voltage measurements. Other differences will also be evident. For example, V1 the ac-signal rectifier and its associated circuits are used only when the WV-77E is set to "AC". A complete performance check will be of great help in isolating the trouble.

When trouble is encountered, a visual check of wiring should be made first. All wiring and solder joints should be inspected closely. Shorted leads or burned components may indicate quickly where the trouble is. The causes and possible remedies listed are given in probable order of occurrence. The description of the trouble should be located in the bold-face type and possible causes checked in the order listed.

When soldering to or near the switches, care should be taken to prevent overheating or mechanically scraping the precision resistors in the

The above effects are a natural phenomena and do not appear during normal application of the instrument because the source impedence of circuits being measured are only a fraction of the instrument impedance. Consequently, the phenomena has no bearing on the accuracy or useability of the instrument.

Resistance Measurements:

When making resistance measurements, the AC-OHMS Probe should be used.

CAUTION: Before resistance measurements are made, the power should be removed from the equipment under test so that no voltages are present in the equipment.

1. Set the function selector to "OHMS" position.
2. Set the range selector to the position nearest to the value under measurement.
3. Connect the probe tip to the ground clip and adjust the ZERO ADJ control to position the pointer at the left-hand "0", if necessary.
4. Disconnect the probe from the Ground Clip. Meter pointer will deflect approximately full scale. If meter pointer does not deflect to exactly full scale, use OHMS ADJ control to adjust setting accurately to the last line on the "Ohms" scale. (See Ohms Adjustment section on page 18 if it is necessary to frequently readjust the OHMS ADJ control.)
5. Connect the clip of the Ground Cable to one terminal of the resistance to be measured.
6. Touch or connect the probe tip to the other terminal of the resistance to be measured.
7. Reset the range switch to give a convenient deflection on the "Ohms" scale.
8. Multiply the reading on the "Ohms" scale by the factor indicated at the range-selector setting. See Table 1.

NOTE: If erratic operation is experienced, it is probably due to a blown fuse, F1, Stock #99328.

CAUTION: Low-current, low-resistance devices, such as thermocouples and meter movements, may be damaged unless a range above "R x 1" is used because the WV-77E applies up to 1.5 volts across the resistance under measurement when the range selector is set at "R x 1".

In the case of resistance measurements, the OHMS Probe of the WV-77E is always positive with respect to the Ground Cable. This facilitates the measurement of leakage resistance in components such as electrolytic capacitors where polarity must be observed.

DC-Voltage Measurements:

CAUTION: See Maximum Input Voltages, under ELECTRICAL SPECIFICATIONS.

Zero Setting of Pointer

Mechanical Adjustment:

The pointer should rest at "0" when the function switch is in the "OFF" position. If the pointer should come to rest at a deflected position, adjust the plastic screw on the front of the meter case so that the pointer lines up with the "0" point on the meter.

If the difficulty remains, vigorously wipe the outside surface of the meter-case window with a clean, soft, dry cloth. If the pointer moves away from its initial position and remains at another off-zero position for several minutes, the anti-static coating on the inside surface of the window is no longer effective. To restore the anti-static coating, apply a small amount of liquid detergent (such as those used for washing dishes) to a soft cloth and gently wipe the front of the meter case. If this procedure is not effective, remove the front of the meter case by carefully prying the top of the case away from the body of the instrument with a thin-bladed screwdriver. Pour a small quantity of the detergent into the plastic case front so that the entire inside surface is covered. Pour the excess liquid out, and allow the case front to dry. Replace the meter front.

DC Zero Check:

1. Set function selector to "—VOLTS", and remove the red lead from the dc jack.
2. Set range selector to "1.5V".
3. Rotate the ZERO ADJ control until the meter pointer is at zero.
4. Turn range selector to "1500V".
5. If the meter pointer deviates from zero by more than one division on the 0 to 15 meter scale, replace the 12AU7-A (see section on Tube Replacement).

AC Zero Check:

1. Set the function selector to "AC" and remove the blue lead from the ac jack.
2. Set the range selector to "1.5V".
3. Rotate the function selector from AC through —DC and +DC.
4. If the meter pointer deflects from "O", adjust the AC BAL control (R-18) so that there is no movement of the pointer as the function selector is rotated.

Calibration

Two methods can be used for the dc voltage calibration of the WV-77E. The first utilizes a readily available source of dc voltage — a fresh

Symbol No.	Description	Stock No.
	Knob: control, blue.	59543
	Knob: control, black rubber.	94878
	Probe: test, red, H. H. Smith, Inc. #319*	220244
	Probe: test, blue, H. H. Smith, Inc. #319*	220245
	Socket: 7-pin miniature Ind. Hardware #MP-14*	
	Socket: Noval Ind. Hardware #NP-16*	
T-1	Transformer: Power.	217921

• Replace only with same type. This fuse is part of the Ohms-divider network.

* Or equivalent.

(Continued from Page 13)

2. Set the meter pointer to zero by adjusting the ZERO ADJ control.
3. Connect the Ground Cable to the negative terminal and the probe tip to the positive terminal of a source of DC Voltage that has been adjusted to exactly 47 volts.
   Note: The accuracy of calibration cannot exceed the accuracy of the voltage standards which are used.
4. Adjust the "DC CAL" control (R-7) inside the case for a meter reading of exactly 47 volts.
5. Remove the leads at the source of voltage.
6. Set the function selector to "—VOLTS".
7. Connect the Ground Cable to the positive terminal and the probe tip to the negative terminal of the dc-voltage source adjusted to exactly 47 volts. The WV-77E should read 47 volts within ±3%.
8. If the WV-77E cannot be calibrated according to the foregoing steps, the 12AU7-A bridge tube may not be properly balanced for this application.

AC-Voltage Calibration

1. Set the Range selector to "150V" and the Function selector to "AC".
2. Connect the AC-OHMS probe and the GROUND probe to a 117 volt ac line or to a variable, metered ac-voltage source. NOTE: See Safety Precautions on page 2.
3. Adjust the AC CAL control (R-6) inside the case for a meter reading of exactly 117 volts.

Tube Replacement

All tubes supplied originally with the WV-77E have been thoroughly aged by operating them for several hours before installation in the instrument. This preliminary conditioning of a new tube helps to insure stability and dependable performance.

Before installing a 12AU7-A, age the tube as follows: Connect the two plates together. Connect both grids and cathodes together. Operate the tube with 115 volts dc applied to the plates, no voltage applied to the grids and cathodes, and 6.3 volts ac applied to the heaters. The tube should be operated in this manner for a minimum of 12 hours before it is installed in the instrument. The WV-77E then can be recalibrated.

An alternate, and usually satisfactory, aging procedure consists of operating the new tube in the WV-77E for approximately 36 to 48 hours, after which time the instrument may be recalibrated. If this procedure is unsatisfactory, the first aging procedure should be followed.

If it becomes necessary to replace the 6AL5, the tube can be aged for a minimum period of 36 hours by operating it in the WV-77E. After this period of time, the instrument may be recalibrated according to the procedure outlined under "AC Calibration Check".

Battery Testing and Replacement

Caution: Do not allow exhausted cells to remain inside the case of the WV-77E. Chemicals from deteriorated cells may damage the instrument.

The battery should be tested to insure accuracy of resistance measurements. To test battery, proceed as follows:

1. Set Function selector to "OHMS".
2. Set Range selector to "R x 1" scale.
3. Rotate OHMS ADJ control to bring pointer to full scale.
4. Short-circuit the probe tip and ground clip for about ten seconds.
5. Open the short-circuit and immediately observe the scale indication. An appreciable deviation from full-scale indication reveals a weak cell which should be replaced.

Ohms Adjustment

In order to obtain exactly full-scale deflection of the meter when switching the range selector from a low range position to the R x 1 MEG position, it may be necessary to readjust the OHMS ADJ control. The

ACCESSORIES

(Available on Separate Order)

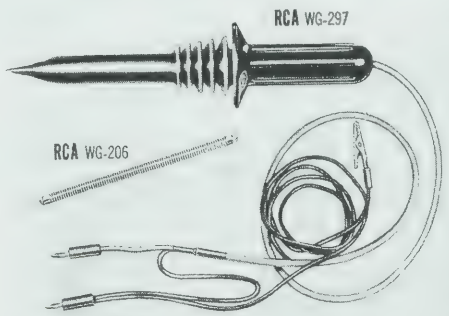
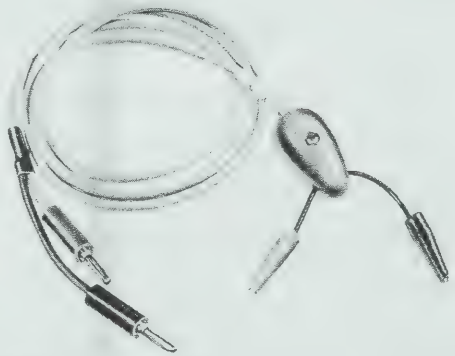


Figure 2A.
WG-297 High Voltage Probe

The WG-297 High Voltage Probe, in combination with the WG-206 Multiplier Resistor, extends the dc rating of the WV-77E and WV-77E(K) VoltOhmysts to a maximum of 50,000 volts. The probe multiplies the dc scales by a factor of 100, and increases the input resistance to 1100 megohms.

Figure 2B.
WG-351A RF Probe

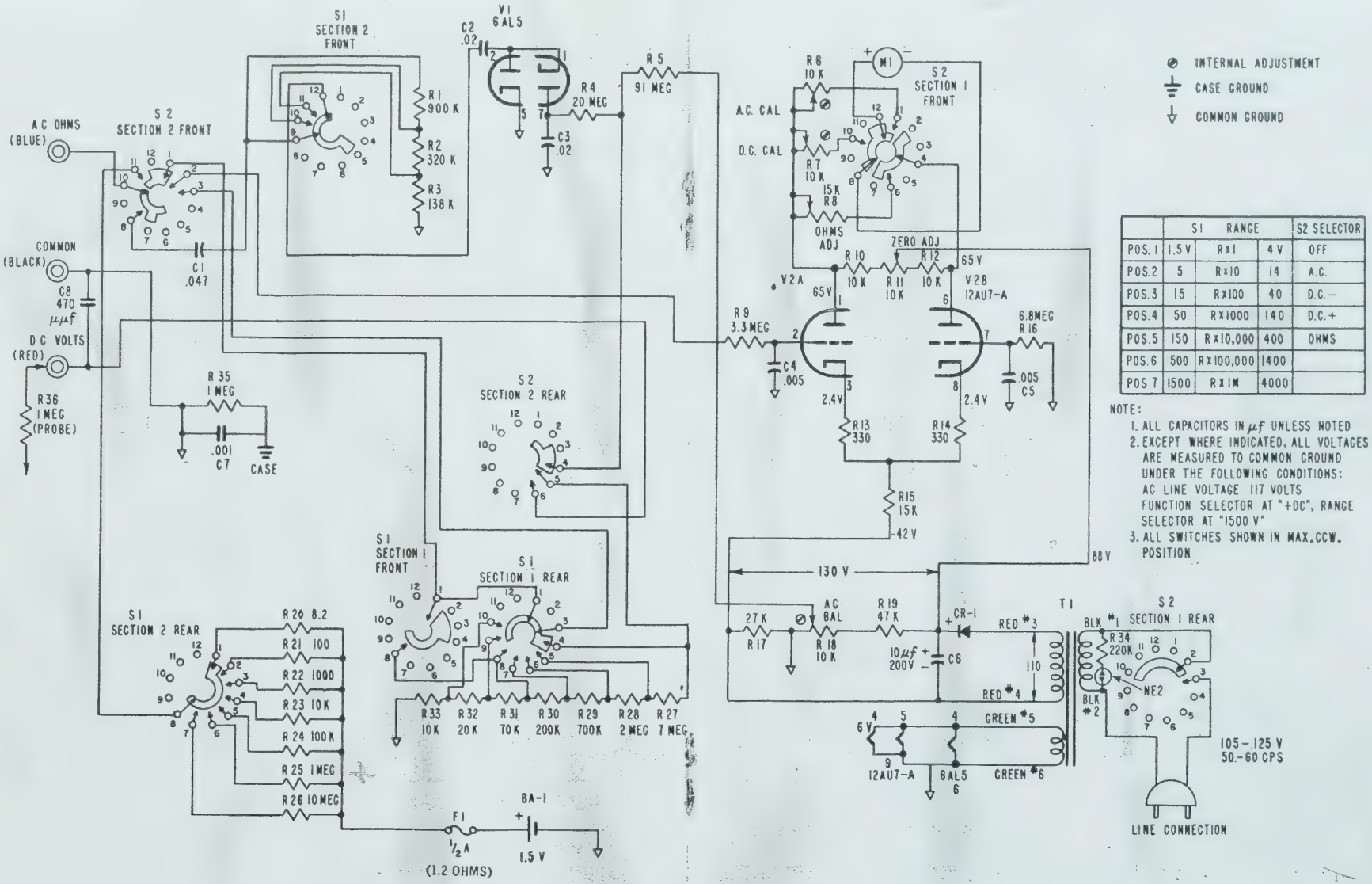
The WG-351A RF Probe consists of a semi-conductor rectifier and an RC network, complete with housing, cable, and banana plugs. The WG-351A reads the rms values of sine waves on the dc scales of the WV-77E and WV-77E(K) VoltOhmysts. The frequency range of the WG-351A is 50 kc to 250 mc, and the maximum voltage rating is 20 rms volts in the presence of 250 dc volts.



Maintenance

The WV-77E may be removed from the case by removing four screws from the front panel. The rubber grommet in the case may also be removed to permit the ac-line plug to pass through the hole in the case.

The performance of the VoltOhmyst is dependent upon the quality and tolerances of its components. Only RCA parts should be used for replacements.



	S1 RANGE			S2 SELECTOR
POS. 1	1.5 V	R x 1	4 V	OFF
POS. 2	5	R x 10	14	A.C.
POS. 3	15	R x 100	40	D.C. –
POS. 4	50	R x 1000	140	D.C. +
POS. 5	150	R x 10,000	400	OHMS
POS. 6	500	R x 100,000	1400	
POS 7	1500	R x 1M	4000	

NOTE:
1. ALL CAPACITORS IN μf UNLESS NOTED
2. EXCEPT WHERE INDICATED, ALL VOLTAGES ARE MEASURED TO COMMON GROUND UNDER THE FOLLOWING CONDITIONS: AC LINE VOLTAGE 117 VOLTS FUNCTION SELECTOR AT "+DC", RANGE SELECTOR AT "1500 V"
3. ALL SWITCHES SHOWN IN MAX. CCW. POSITION

Schematic Diagram of the WV-77E

Replacement Parts List

WV-77E VoltOhmyst

When ordering replacement parts, include the stock number and description of the part, the instrument type, and the code number. Parts without stock numbers are standard catalog items. All parts should be ordered from your local RCA distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1	Tubular, 0.047 μf ±20%, 400 volts	73553
C2, C3	Ceramic disc, 0.02 μf ±20%, 400 volts	210685
C4, C5	Ceramic disc, 0.005 μf GMV, 200 volts Centralab type DD*	
C6	Electrolytic, 10 μf −10%, +100%, 200 volts	218002
C7	Ceramic disc, 0.001 μf GMV, 500 volts	77252
C8	Ceramic disc, 470 μμf, 1600 volts	103902
CR1	Rectifier: Selenium Radio Receptor Co. #8Y1B*	
F1	Fuse: ½ amp, pigtail, 3 AG (Littelfuse or Buss GJV)*	99328
NE2	Lamp: Neon, 5" leads	218017
M1	Meter, 400 μA	217925
	Resistors	
R1	Carbon film: 900,000 ohm ±1%, 1 watt	59536
R2	Carbon film: 320,000 ohm ±1%, ½ watt	59544
R3	Carbon film: 138,000 ohm ±1%, ¼ watt	218021
R4	20 meg ±5%, ¼ watt	
R5	91 meg ±20%, ½ watt	218020
R6, R7	Variable: 3 sect., 10,000 ohm, ±35%, ½ watt, plug-in type. Includes R6, R7, R18	217922
R8	Variable: 15,000 ohm, ±20%, ¼ watt	218019
R9	3.3 meg, ±10%, ½ watt	
R10	10,000 ohm ±5%, ½ watt	
R11	Variable: 10,000 ohm ±20%, ¼ watt	218018
R12	10,000 ohm ±5%, ½ watt	
R13, R14	330 ohm ±5%, ½ watt	
R15	15,000 ohm ±5%, ½ watt	
R16	6.8 meg, ±10%, ½ watt	
R17	27,000 ohm ±5%, ½ watt	
R18	Part of R6	
R19	47,000 ohm ±5%, ½ watt	
R20	Wire wound: 8.2 ohm ±5%, 5 watt	210535
R21	100 ohm ±5%, ¼ watt	
R22	1000 ohm ±5%, ¼ watt	
R23	10,000 ohm ±5%, ½ watt	
R24	100,000 ohm ±5%, ¼ watt	
R25	1 meg, ±5%, ¼ watt	
R26	10 meg, ±5%, ¼ watt	
R27	Carbon film: 7 meg, ±1%, ¼ watt	59538
R28	Carbon film: 2 meg, ±1%, ¼ watt	59540
R29	Carbon film: 700,000 ohm ±1%, ¼ watt	59541
R30	Carbon film: 200,000 ohm, ±1%, ¼ watt	56733
R31	Carbon film: 70,000 ohm, ±1%, ¼ watt	59542
R32	Carbon film: 20,000 ohm, ±1%, ¼ watt	213657
R33	Carbon film: 10,000 ohm, ±1%, ¼ watt	209648
R34	220,000 ohm, ±20%, ½ w	
R35	1 meg, ±5%, ¼ watt	
R36	1 meg, ±5%, ¼ watt	
	Switches	
S1	Switch: Rotary "Range"	217924
S2	Switch: Rotary "Selector"	217923
	Miscellaneous	
	Board: laminated circuit	217929
	Case: meter, front, clear plastic	217926
	Case: meter, rear, clear plastic	217927
	Clamp: battery Prestole #501-750-14S*	
	Connector, banana plug H. H. Smith. 1165AX	
	Connector: alligator clip Mueller #60/Philmore #1956A*	
	Cord: power cord and plug	70392
	Foot: case, rubber, Atlantic India Rubber Co. #716*	
	ground cable	220246
	Handle: carrying handle and pouch assembly	217930
	Jack, amphenol 78-IL	

Unless otherwise stated all resistors shown are composition type.

flashlight cell, the other utilizes a variable, metered power supply. Remember that the accuracy of the instrument is dependent on the accuracy of the calibration voltage.

DC-Voltage Calibration

Method 1

1. Set the Range selector to "1.5V" and the Function selector to "+DC" volts.
2. Set the meter pointer to zero by using the ZERO ADJ control.

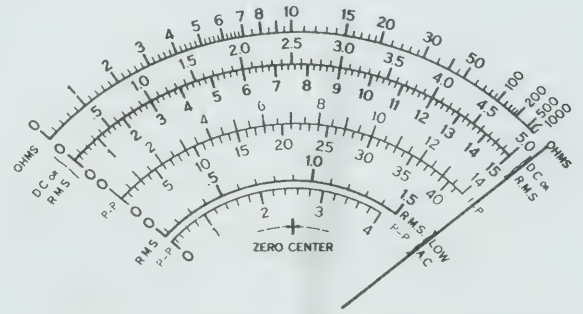


Figure 3. Position of the Meter Pointer for dc-Voltage Calibration (Method 1)

3. Connect the GROUND Cable to the negative side and the DC probe to the positive side of a fresh flashlight battery, such as the RCA-VSO35.
4. Adjust the "DC CAL" control (R-7) inside the case so that the meter pointer is positioned just to the right of the bracket on the 5/15 meter scale (See Fig. 3). This point has a value of 1.55 volts.
   Note: A calibrated cell is not required since a fresh flashlight battery will measure 1.55 volts.
5. Disconnect the leads from the battery. The instrument should now be ready for use on any dc range.

Method 2

1. Set the Range selector to "50V" and the Function selector to "+VOLTS".

Continued on Page 17

WG-289

HIGH-VOLTAGE PROBE

RCA WG-289 High-Voltage Probe, when fitted with the proper multiplier resistor, is used to increase the dc-voltage range of voltmeters up to 50,000 volts. This probe is equipped with a microphone type connector and is intended for use with instruments such as the WV-98A Senior VoltOhmyst ® which can accomodate this connector. The WG-289 is especially suited for the measurement of high voltages in television receivers and other equipments which have high-impedance circuits.

Most vacuum-tube voltmeters have a constant input resistance of 11 megohms on all dc ranges. The input resistance includes the 1-megohm isolating resistor in the dc probe. This feature permits the use of a single multiplier resistor to increase the range of all dc measurements by the same factor.

The WG-289 in combination with the WG-206 Multiplier Resistor has an input resistance of 1090 megohms. When used with a VoltOhmyst such as the WV-98A, the combined input resistance is 1100 megohms. This value of input resistance is 100 times as great as the input resistance of the VoltOhmyst (11 megohms) when the instrument is used to make dc voltage measurements. The dc voltage range is, therefore, increased by a factor of 100. For example, the WV-98A VoltOhmyst, when used with the WG-289 in combination with the WG-206, provides full-scale ranges of 150, 500, 1500, 5000, 15000, and 50000 volts. (The 1500 volt scale or range is not used).

SAFETY PRECAUTIONS

Although the WG-289 is designed to minimize the possibility of shock, it is assumed that the user is familiar with the necessary precautions for safe measurement of high voltages. When making measurements always observe the safety precautions listed below.

1. Know the equipment under test, and locate all high-voltage points before work is started. Be extremely careful with receivers or other electrical appliances which do not use pulse-operated or rf power supplies.
2. Do not work alone. Notify another person that you are making high-voltage tests.
3. Work with one hand, and keep the other hand in pocket.
4. Don't depend on the insulation of a high-voltage wire for protection.
5. Avoid contact between any part of the body and any object that can provide a ground.
6. Always measure the supply voltage at the second-anode terminal of the picture tube, is possible. (Most TV receivers have a current-limiting resistor which limits the available power at the second-anode terminal.)
7. Remember that high voltage may appear at unexpected points in defective equipment. Furthermore, bleeder resistors may be open and capacitors may retain heavy charges although power is off. A high-resistance voltage source may become a low-resistance (high-power) source, if the current-limiting resistor becomes shorted.
8. Remember that many picture tubes have a conductive coating which serves as a capacitor. This coating discharges slowly.
9. Screwdrivers should not be used to discharge filter capacitors. Use only a grounded chain or wire attached to the end of a long Bakelite rod.
10. Remember that high voltages will discharge from point to point or from point to air (corona). Keep hand closed on handle of probe and in the clear away from all high-voltage points.
11. When using, place the probe in such a manner that the guard-ring will be closer to any high-voltage danger point than is the handle.
12. Keep your hands, shoes, floor, and test bench absolutely dry.
13. Make sure that the probe has no dirt, grit, or grease on its surface or handle.

ASSEMBLY

1. Unscrew the handle from the probe body. Do not touch or mar the guard ring.
2. Place multiplier resistor in the space provided. Avoid sharp blows or scratches that might damage the resistor element.
3. Replace handle.

APPLICATION

To use the probe, proceed as follows:

1. Screw the microphone connection onto the microphone jack on the VTVM.
2. Set the Range Selector to the proper voltage range.

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ELECTRON TUBE DIVISION
Radio Corporation of America, Harrison, New Jersey
(Test Equipment, Camden, N.J.)

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3. Connect the ground clip of the WG-289 to the ground of the equipment under test.

4. Hold the high-voltage probe by the handle (black) only and touch the probe tip to the test point. Be sure that the guard ring on the probe is closer to the test point than is the handle. Note the meter reading.

5. Multiply the reading by the scale factor to give the actual voltage. For example if the scale reading is 225 volts on the WV-98A, the actual voltage is 22,500 volts.

6. When taking measurements around 50,000 volts, keep the probe tip on the test point only long enough to take a reading, to prevent possible inaccuracies due to heating of the multiplier resistor.

MAINTENANCE

Always keep the high-voltage probe clean and dry; disassemble the probe, if necessary, to dry the interior. Wipe the probe body with a dry cloth before measurement is made.

In case of erratic operation, check the meter to determine whether it operates properly on the dc ranges. If meter operation is satisfactory, check the cable and the connectors by measuring for continuity in the cable. The resistor may be checked by using an ohmmeter which can measure very high resistance values, or by means of dc measurements as described in the instruction booklet supplied with the WV-98A.

REPLACEMENT PARTS LIST

Description	Stock Number
Clip, alligator	35262
Connector, microphone type	48982
Handle, probe - polystyrene (black)	58868
Probe, body and tip assembly - polystyrene (red)	58867
Resistor, multiplier - 1090 meg., ± 2% ..... Type No.	WG-206

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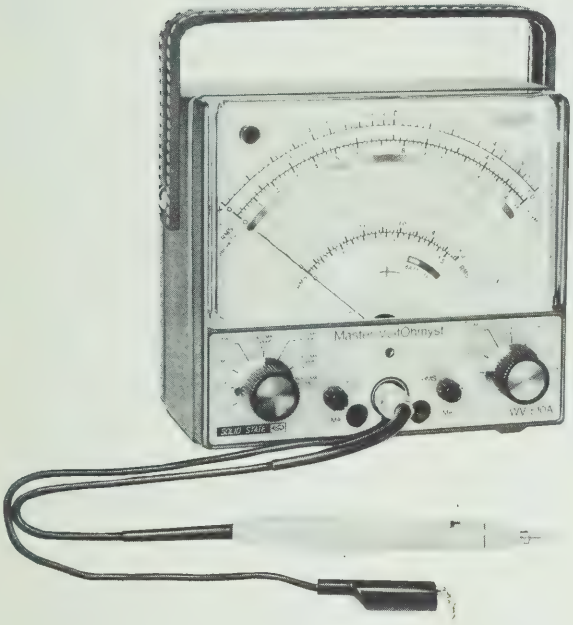

operating and
maintenance instructions

WV-510A Solid-State Master VoltOhmyst®

RCA | Electronic Instruments | Harrison, N.J. 07029

Safety Precautions

For proper operation, the ground (black) lead of the WV-510A should be connected to the ground of the equipment under test before any other connections are made. To minimize shock hazard, the case of this instrument is isolated from the circuit ground by a resistor-capacitor parallel network. When the ground lead of the instrument is connected to a point with high above-ground potential, however, it is possible that there will be voltage on the case. For this reason, do not touch the instrument case or permit the case to touch other equipment when high voltage is being measured. An important point to remember is that there is always danger inherent in testing electrical equipment. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below:

1. Always use an isolation transformer, such as the WP-25A or WP-26A Isotap, when working with AC/DC equipment having the chassis connected directly to one side of the AC power line. (Use the Isotap sockets marked "ISOLATED" for this purpose.)
2. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.
3. Filter capacitors may store a charge large enough to be lethal. Therefore, discharge filter capacitors before attaching test leads.
4. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.
5. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.
6. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in jeopardy of more serious risks, such as a bad fall or contact with a source of higher voltage.
7. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

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Items Supplied with the WV-510A

DC/AC-OHMS Probe Cable, WG-401A
Test Leads, for current measurement
Slip-on Alligator Clip, for probe
1 RCA VS036A Battery
NOTE: For battery operation, four 9-volt batteries are required. Use RCA VS323, or equivalent.

Accessories Available Separately

Crystal-Diode Probe WG-301A
Increases AC frequency range to 250 MHz
High-Voltage Probe (less resistor) WG-411A
Increases DC voltage range to 50,000 volts
Multiplier Resistor for WG-411A WG-436A

Description

The RCA WV-510A Master VoltOhmyst is a high-quality, solid-state electronic voltmeter especially designed for stable, drift-free operation. The instrument can be operated either from internal batteries (not included) or from a 120 volt AC power line. On battery operation, the power cord can be removed for complete portability. The many features of this VoltOhmyst make it ideally suited to service, industrial, and laboratory applications.

The WV-510A measures DC voltage from 0.01 to 1500 volts, direct current from .01 milliamperes to 1.5 amperes, AC RMS voltage from 0.2 to 1500 volts, AC peak-to-peak voltage of complex waveforms from 0.5 to 4200 volts, and resistance values from 0.2 ohms to 1000 megohms.

Seven overlapping ranges are provided for AC voltage, DC current, and resistance measurements, and eight ranges are provided for DC voltage measurement. Accuracy for all voltage and current functions is ±3% of full-scale reading.

The solid-state measuring circuit in the WV-510A features excellent stability and linearity, with minimum effect caused by temperature variations. Current drain is very low, assuring long battery life. Accuracy is maintained throughout the usable life of the batteries. A convenient battery test function is provided.

An input resistance of 21 megohms on all DC ranges permits accurate test results on even the most critical low impedance circuits.

All voltage and resistance measurements are made with the WG-401A single-unit probe with extra-flexible shielded cable. The cable is equipped with a high-quality BNC-type connector. The probe can quickly be adapted to measure DC or AC and resistance by a convenient built-in switch.

Separate test leads are provided for current measurement. The function switch is specially designed so that the two current input jacks are connected together in all functions except current measurement. This feature permits alternate voltage and current measurements without disconnecting the currect test leads from the test circuit.

The frequency response of the AC function can be extended to 250 MHz through the use of an accessory crystal diode probe, the WG-301A. This probe slips onto the WG-401A for a sturdy insulated RF probe without the use of an additional cable.

The DC voltage range can be extended to 50,000 volts through the use of the WG-411A Slip-On High Voltage Probe and WG-436A Multiplier Resistor.

A 1.5-volt "D" size battery is provided with the WV-510A for operation of the ohms circuit. For complete battery operation, four 9-volt batteries (RCA VS323 or equivalent) must also be installed. To assure maximum battery life, the WV-510A circuit provides a "trickle" charge to the 9-volt batteries when the unit is used on AC power.

The Master VoltOhmyst has a large, easy-to-read, two-color meter. A mirror scale is included to prevent inaccurate readings due to parallax. The instrument is attractively styled with a rugged diecast aluminum case and brushed aluminum panel. Weight is only 3½ pounds. Measurements are 6⅞ inches by 5¼ inches by 3⅛ inches.

Specifications

Electrical

NOTE: Performance figures are for line voltage of 120 volts, 60 Hz.

DC Voltmeter

Ranges ..... 0 to .5, 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance (with switch on WG-401A set to "DC"):
All Ranges ..... 21 Megohms
Accuracy ..... ±3% of full scale reading

DC Current

Ranges ..... 0 to .5, 1.5, 5, 15, 50, 150, 500, and 1500 mA
Accuracy ..... ±3% of full scale reading
Insertion Loss ..... 250 mV on all current ranges

AC Voltmeter

Ranges:
RMS ..... 0 to 1.5, 5, 15, 50, 150, 500, and 1500 volts
Peak-to-Peak ..... 0 to 14, 42, 140, 420, 1400, 4200 volts
Accuracy ..... ±3% of full scale reading
(Accuracy of RMS ranges based on use of sine wave signals having less than ½ of 1.0% total harmonic content.)

Input Resistance and Capacitance

(With WG-401A switch set to "AC-OHMS"):
1.5, 5, 50, 150 V Ranges ..... 0.83 meg, shunted by 70 pF
500 V Range ..... 1.3 meg, shunted by 60 pF
1500 V Range ..... 1.5 meg, shunted by 60 pF

Frequency Response

At 1.5 and 5.0 V AC ..... ±1 DB 30 Hz to 3 MHz

Maximum Input Voltages

DC Voltages with no AC voltage present: ..... 1500 volts
AC Voltages with no DC voltage present:
RMS for Sine Waves ..... 1500 volts
Peak-to-Peak for Sine Waves ..... 4200 volts
Peak-to-Peak for Complex Waves ..... 2000 volts
Combined AC and DC Voltages:
Sum of DC Voltage and AC Peak Voltage ..... 2000 volts

Ohmmeter

Ranges, Seven ..... 0 to 1000 megohms
Accuracy ..... ±3% of center scale reading

Meter Movement

DC Current for Full-Scale Deflection ..... 200 uA

Power Required

AC Operation:

Voltage	110-135 volts (May be wired for operation on 240V. See page 22.)
Frequency	50/60 Hz
Power Consumption	less than 5 watts
Battery Operation:	four 9-volt batteries RCA VS323 or equiv. (NEDA 1604) (Not included)
Ohms Circuit	one 1.5-volt "D" cell. RCA VS036 or equiv.

Mechanical

Dimensions (less handle)

Height	6½ inches
Width	7 inches
Depth	3¾ inches

Weight

(With batteries)	3½ pounds

Operation and Applications

The WV-510A can be operated either from a 120 volt, 50/60 Hz AC power line, or from internal batteries. For AC operation simply connect the power-line cord from the instrument to a 120 volt outlet.

For battery operation, four 9-volt batteries must be installed. Follow battery installation instructions on page 18. The batteries can be kept in the instrument while it is being operated from an AC power line. For battery-operated portable use, the power line cord can be unplugged from the VoltOhmyst. Note: The pilot light will not glow when instrument is battery operated.

Battery Test

If the four 9-volt batteries are installed, they can be tested as follows:

Unplug AC power cord and set function switch first to BATT TEST A, then to B. The meter pointer should not read below the green area on the BATT TEST scale on either A or B. If batteries do not test good, replace as described on page 18.

To test the 1.5 volt D cell used in the ohmmeter function, set the function switch to R OHMS. Short probe tip to ground lead clip, and adjust ZERO control so that pointer indicates "0". Disconnect probe tip from ground clip, and turn OHMS control fully clockwise. If battery is good, meter pointer can be adjusted to full-scale.

Use of WG-401A Probe and Cable

The WG-401A DC/AC-OHMS Probe and Cable supplied with the WV-510A is equipped with a sliding switch in the probe body to permit changing the probe characteristics to suit the type of measurement being made. When the sliding switch is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the WV-510A. This resistor acts to isolate the instrument from the circuit under test when DC voltage measurements are made and is a part of the over-all input resistance of the voltmeter. The switch should always be set to the "DC" position when DC voltage measurements are made.

When the sliding switch is set to the "AC-OHMS" position, the isolating resistor is shorted out and the signal or test voltage is fed directly from the probe tip to the input of the WV-510A. The switch should always be set to the "AC-OHMS" position when resistance or AC voltage measurements are made.

Use of Range Switch and Meter Scales

The meter scales on the WV-510A have been designed to provide ease of operation and quick readability over a wide range of measurements. Scales are grouped conveniently for the type of measurement for which they are used. The "R" scale, at the top of the scale plate, is used only for resistance measurements, and all resistance measurements are read from this one scale. All DC voltage and current is read from the two scales marked "A" and "B" in Figure 1. The remaining scales are used only for AC voltage measurements. The RMS values of sine-wave voltages above 5 volts are also read from scales marked "A", "B". The low AC RMS scales, "G" and "H", are used for RMS measurements below 5 volts. Peak-to-peak AC readings are made on the red scales, "C", "D", "E", and "F". The particular scale which is used for any given function is determined by the setting of the range switch.

The charts on the following pages have been prepared as an aid in selection of ranges, scales, and multiplying factors for all measurements which can be made with the WV-510A.

Because of the wide number of measurement ranges provided on the WV-510A, it is often possible to take readings on two ranges and scales. For greatest accuracy in voltage and current measurements, always use the range which will provide an on-scale

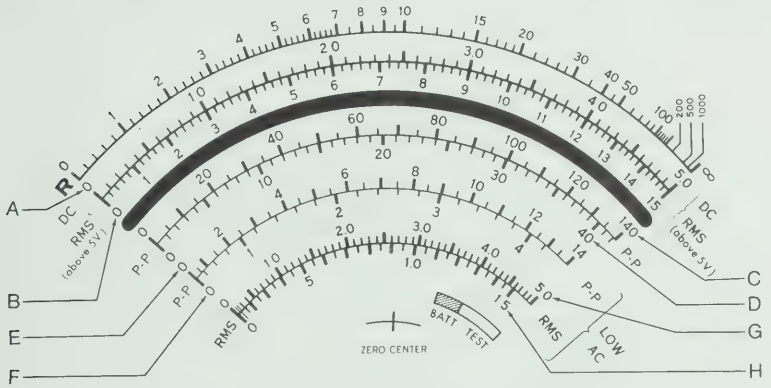


Figure 1. WV-510A Meter Scales

reading which is nearest to the full-scale point. For example, 48 DC volts can be read from either the 50 volt or the 150 volt range. Because the 50 volt range will provide a reading nearest the full-scale point, the 50 volt range only should be used if a reading of best accuracy is to be obtained. For ohms measurements, however, the range selected should be the one which provides a reading nearest the center of the scale because the VoltOhmyst provides the most accurate readings at mid-scale points.

For some measurements it will be necessary to use a multiplying factor with the scale reading to obtain the correct reading. The required multiplier is indicated by the setting of the range switch. These ranges correspond to the full-scale values shown on the right side of the meter scales. For example, when the range switch is set to the 500 volt position for a DC voltage measurement, the "A" scale (Figure 1) is used. Because this scale has a full scale value of "5", it is necessary to multiply any readings on this scale by 100 to obtain the correct value.

DC-Voltage Measurements

NOTE: The sliding switch on the WG-401A should be set to "DC" for all DC voltage measurements. Maximum input voltages must not be exceeded. See "Specifications" and "Safety Precautions".

The WV-510A has eight DC voltage ranges: 0 to .5, 1.5, 5, 15, 50, 150, 500, and 1500 volts. Although the meter is protected against burn-out under ordinary overloads, it is good practice to make a trial measurement at a range setting higher than the voltage expected. Continued or repeated overloads may impair the accuracy of the movement. To measure DC voltages, proceed as follows:

1. Set the function selector to "+ DC VOLTS" or to "− DC VOLTS", as required.
2. Connect the clip of the ground cable to the ground of the circuit under test.
3. Set the range selector to a range position higher than the voltage to be measured.
4. Touch or connect the probe tip to the high side of the source voltage.

DC-VOLTAGE MEASUREMENTS
(Set Function switch to "−DC VOLTS" or "+DC VOLTS" and set probe switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0 to .5V	.5V DC	A	.1
.5 to 1.5V	1.5V	B	.1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	1
15 to 50V	50V	A	10
50 to 150V	150V	B	10
150 to 500V	500V	A	100
500 to 1500V	1500V	B	100

5. Reset range selector to a position which gives a reading nearest to full scale.
6. Read the DC voltage from the scale corresponding to the range selector setting.

Zero Center

Zero-center indication is frequently useful because it allows observation of either positive or negative DC-voltage excursions without the necessity of resetting the function selector.

1. Set the function selector to "+ DC VOLTS".
2. Rotate the ZERO control to position the pointer at the zero center mark, which is located near the bottom center of the meter dial. If the ZERO control does not have sufficient range to center the pointer, switch the function selector to "− DC VOLTS".
3. Set the range selector to a position at least twice the voltage to be measured.
4. After a test reading has been made, the range control may be set to the lowest position which allows the pointer to remain on the scale.

DC Current Measurement

The WV-510A has eight DC current ranges: 0 to .5, 1.5, 5, 15, 50, 500, and 1500 mA (1.5A). Separate leads are provided for measuring current — the WG-401A probe is not used. Insert the black lead into the "−mA" panel jack, and the red test lead in the "+mA" jack. The current test jacks are shorted together on all functions except "DC CURRENT". Voltage and current measurements can alternately be made without disconnecting the current test leads.

1. Remove power from the circuit under test.
2. Set the function switch to "DC CURRENT" and the range switch to a position higher than the current to be measured.
3. Connect the test leads in series with the circuit in which the current is to be measured. If necessary, break the circuit at a convenient point by disconnecting or unsoldering a connection. Connect

DC CURRENT MEASUREMENTS
(Set Function switch to DC Current. Use red "+mA" lead and black "−mA" lead.)

DC Current to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0 to .5 mA	.5V/mA	A	.1
.5 to 1.5 mA	1.5V/mA	B	.1
1.5 to 5 mA	5V/mA	A	1
5 to 15 mA	15V/mA	B	1
15 to 50 mA	50V/mA	A	10
50 to 150 mA	150V/mA	B	10
150 to 500 mA	500V/mA	A	100
500 to 1500 mA (1.5A)	1500V/mA	B	100

the black test lead to the negative side of the circuit and the red lead to the positive side of the circuit.

4. Apply power to the circuit under test. Reset the range switch to a position which gives a suitable meter pointer deflection.
5. Read current from the scale corresponding to the range switch setting.

AC-Voltage Measurements

CAUTION: Maximum input voltages must not be exceeded. The accuracy of meter indications is dependent upon the frequency of the AC voltage being measured, the waveshape, repetition rate, and the impedance of the voltage source. See "Specifications", page 5, and the section below for additional information.

The switch on the WG-401A Probe should be set to "AC-OHMS" for all AC voltage measurements.

1. Set the function selector to "AC".
2. Adjust the ZERO control if necessary to position the meter pointer at the left-hand "0".
3. Set the range control to a position considerably higher than the voltage to be measured.
4. Connect the ground cable to the ground side of the voltage to be measured.
5. Touch or connect the probe tip to the high side of the source voltage.
6. Reset the range control for a convenient deflection.
7. Read the AC voltage from the scale corresponding to the range control setting.

The meter scales of the WV-510A are calibrated in both RMS and peak-to-peak voltages. Peak-to-peak voltage values are read from the red scales marked "P-P"; RMS values of sine waves are read from the black scales marked "RMS".

When it is desired to know which peak-to-peak scale is used, the indication is taken from the markings on the range switch positions. Position 2 for example, is labeled "5V" and "14V". These figures correspond to the full-scale values of the corresponding RMS and peak-to-peak scales.

AC RMS VOLTAGE MEASUREMENTS
(Set Function switch to "AC" and set probe switch to "AC-OHMS".)

RMS voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent peak-to-peak-value:	
				Use Scale	Multiply by
0.1 to 1.5V	1.5V	H	1	F	1
1.5V to 5V	5V	G	1	E	1
5 to 15V	15V	B	1	D	1
15 to 50V	50V	A	10	C	1
50 to 150V	150V	B	10	D	10
150 to 500V	500V	A	100	C	10
500 to 1500V	1500V	B	100	D	100

AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS
(Set Function switch to "AC" and set probe switch to "AC-OHMS".)

Peak-to-peak voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent RMS value:	
				Use Scale	Multiply by
0.2 to 4V	4.0V	F	1	H	1
4 to 14V	14V	E	1	G	1
14 to 40V	40V	D	1	B	1
40 to 140V	140V	C	1	A	10
140 to 400V	400V	D	10	B	10
400 to 1400V	1400V	C	10	A	100
1400 to 4200V	4000V	D	100	B	100

Examples of typical voltage waveforms found in television circuits are shown in Figure 2. Examples of other types of basic waveforms which can be measured by the WV-510A are shown in Figure 3.

The instrument has a maximum rated input for non-symmetrical waveforms of 200 peak-to-peak volts. Sine waves and symmetrical complex waves up to 4200 peak-to-peak volts can be measured with somewhat reduced frequency response. (See Maximum Input Voltages under "Specifications".)

Reliable AC voltmeter readings can be assured only if the characteristics of the voltmeter are compatible with the characteristics of the circuit under test. When the WV-510A is used to measure AC voltages, the "Specifications" on page 5 should be considered. Information on input resistance and capacitance, frequency response, and pulse response is given.

When any voltmeter is used to measure AC voltages, certain precautions in the interpretation of readings are necessary because connection of the

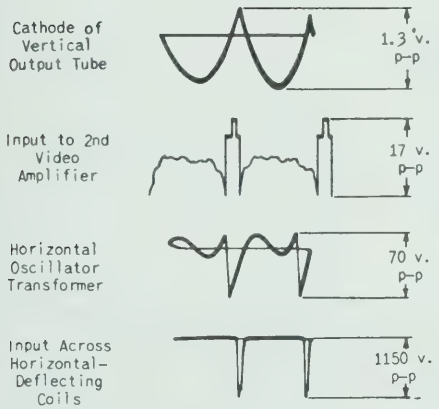


Figure 2. Typical television waveforms

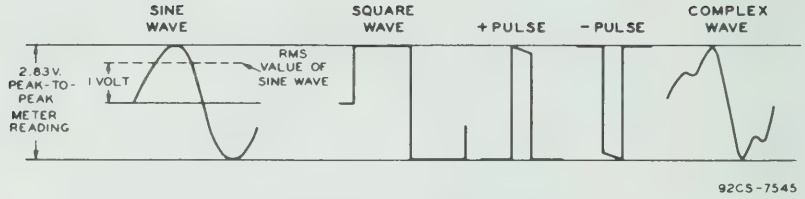


Figure 3. Typical voltage waveforms

meter to the circuit may cause some disturbance. This is also true of the VoltOhmyst but its high input impedance minimizes such disturbances. The amount of circuit disturbance caused by the voltmeter is usually reflected in a decreased circuit voltage, the amount of decrease being dependent upon the characteristics of both the voltmeter and the test circuit.

For example, inaccurate readings of normal circuit conditions can be obtained from any one or a combination of the following conditions:

1. If measurements are made in high-impedance circuits. The instrument will cause loading of the circuit to a degree dependent upon the ratio of the circuit impedance to the voltmeter impedance. As this ratio increases, the loading effect of the voltmeter is increased with a corresponding change in the normal operating conditions of the circuit.
2. If the capacitance of the circuit is low in relation to the input capacitance of the voltmeter.
3. If the frequency of the source voltage is higher than the upper frequency rating of the voltmeter.
4. If the voltage waveform in the test circuit consists of narrow pulses with a low repetition rate.

The last of these four conditions needs careful consideration in order to interpret correctly the peak-to-peak readings of the VoltOhmyst. The values of the circuit capacitors and resistors used in the peak-to-peak rectifier circuit of the WV-510A have been chosen to give a discharge time which will provide a reliable peak-to-peak reading over its specified frequency range. If pulses of extremely short duration are applied to the rectifier circuit, the capacitors may not charge to the peak-voltage value of the pulse. If pulses with a low repetition rate are applied to the rectifier circuit, the capacitors will dissipate an appreciable part of the charge by the time the next pulse is applied. As a result, the capacitors are not charged to the full peak-to-peak value of the voltage. Therefore, both the RMS and peak-to-peak voltage indications will be lower than the true value of the applied voltage.

DBM Measurements

The graph on page 14 can be used to determine dbm values corresponding to RMS AC-voltage values across a 600-ohm resistive load. A dbm value is defined as the number of decibels above or below a reference level of 1 milliwatt in 600 ohms at 1000 cycles.

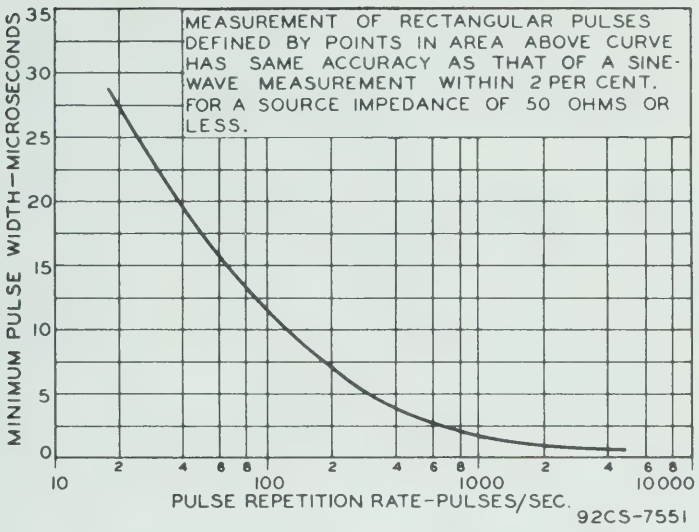


Figure 4. Pulse repetition capability of the WV-510A

Zero dbm, therefore, would indicate a power level of 1 milliwatt; 10 dbm, 10 milliwatts; and 20 dbm, 100 milliwatts.

The graph makes possible rapid conversion of RMS voltages to corresponding dbm values. Associated power levels can be read along the top of the graph. If the RMS voltage is measured across a resistive load other than 600 ohms, the correction factors given below must be added algebraically to the dbm values read from the graph in Figure 5. For resistive loads not given in the table, the following formula should be used for determining the correction factor:

$$\text{Correction Factor} = 10 \log \frac{600}{R}$$

where R is the load in ohms. If R is greater than 600 ohms, the correction factor is negative.

Because dbm is defined with respect to a 600-ohm load, power levels correspond to voltage values. DBM can be measured in terms of RMS voltages across a 600-ohm resistive load. For example, 0.775 RMS volt indicates 0 dbm; 7.75 RMS volts indicate 20 dbm. While these measurements must be made with a sine waveform to avoid waveform error, any frequency can be used which is within the range of the WV-510A. The decibel and ear-response curves have their closest correlation at 1000 cycles.

Resistive Load at 1000 cps	DBM*
600	0
500	+0.8
300	+3.0
250	+3.8
150	+6.0
50	+10.8
15	+16.0
8	+18.8
3.2	+22.7

*DBM is the increment to be added algebraically to the dbm value read from Figure 5.

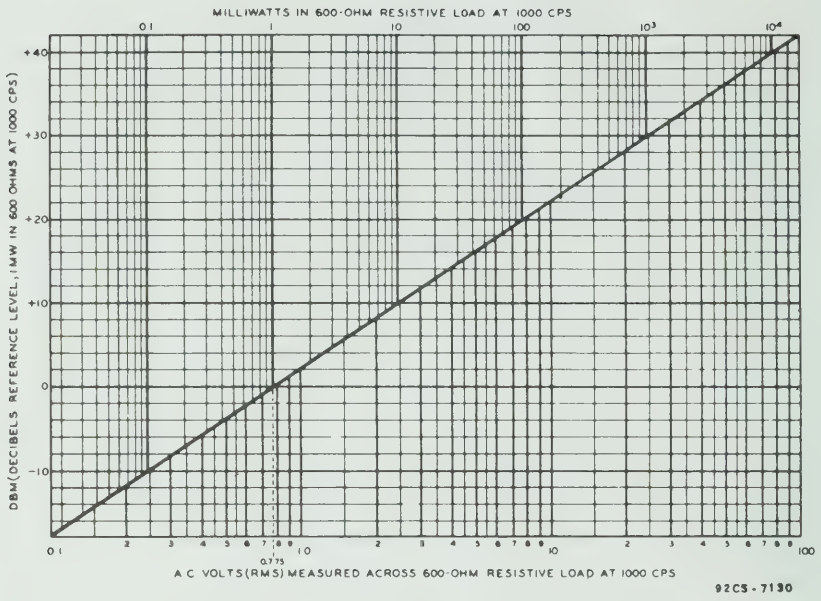

MILLIWATTS IN 600-OHM RESISTIVE LOAD AT 1000 CPS
DBM(DECIBELS REFERENCE LEVEL, 1 MW IN 600 OHMS AT 1000 CPS)
A C VOLTS(RMS) MEASURED ACROSS 600-OHM RESISTIVE LOAD AT 1000 CPS
92CS-7130

Figure 5. Graph for conversion of rms to dbm values

Resistance Measurements

NOTE: The sliding switch on the WG-401A probe should always be set to "AC-OHMS" when resistance measurements are to be made.
CAUTION: The power should be removed from the equipment under test, and any capacitors should be discharged so that no voltages are present in them.

1. Set the function selector to the "R OHMS" position.
2. Set the range selector to the position nearest to the value under measurement.
3. Short the probe tip to the ground cable and adjust the ZERO control to position the pointer at the left-hand "0", if necessary.
4. Separate the probe tip from the ground cable. Adjust the OHMS control to bring the meter pointer to exactly full-scale.
5. Connect the clip of the ground cable to one terminal of the resistance to be measured.
6. Touch or connect the probe tip to the other terminal of the resistance to be measured.
7. Reset the range control to give a convenient deflection on the "R" (ohms) scale.
8. Multiply the reading on the "R" scale by the factor indicated by the range control setting.

CAUTION: Low-current, low-resistance devices, such as thermocouples, meter movements, and semi-conductor devices may be damaged unless a range higher than "R x 10" is used because the WV-510A applies up to 1.5 volts across the resistance under measurement when the range control is set at "R x 1" or "R x 10".

RESISTANCE MEASUREMENTS
(Set Function switch to "R OHMS" and set probe switch to "AC-OHMS".)

Resistance to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 1000Ω	R X 1	R	1
1000 to 10000Ω	R X 10	R	10
10000 to 100000Ω	R X 100	R	100
100000Ω to 1 MEG	R X 1000	R	1000
1 MEG to 10 MEG	R X 10K	R	10000
10 MEG to 100 MEG	R X 100K	R	100000
100 MEG to 1000 MEG	R X 1 MEG	R	1 MEG

Measurement of Resistance Values Above 1000 Megohms

The leakage resistance of small mica and paper capacitors is usually above 1000 megohms. The circuit shown in Figure 2 can be used to measure resistance values above 1000 megohms. An external DC-voltage source between 20 and 500 volts is utilized to obtain a measurable pointer deflection. Make circuit connections as shown in Figure 6 and proceed as follows:

1. Set function selector to "– DC VOLTS" and measure the voltage at point B.
2. Measure the voltage at point A.
3. Compute the unknown resistance from the following formula:

$$Rx \text{ (megohms)} = \frac{11\ [(\text{Volts at "A"}) - (\text{Volts at "B"})]}{(\text{Volts at "B"})}$$

EXAMPLE: The value of an unknown resistance is to be determined with the circuit of Figure . An external voltage of 500 volts is applied. The WV-510A measures 2.5 volts at "B", and 500 volts at "A". Then,

$$Rx = \frac{11\ (500\text{-}2.5)}{2.5}$$

= 2200 megohms (approx.)

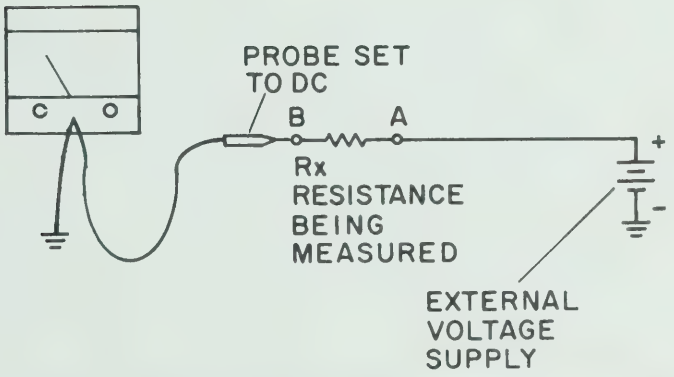
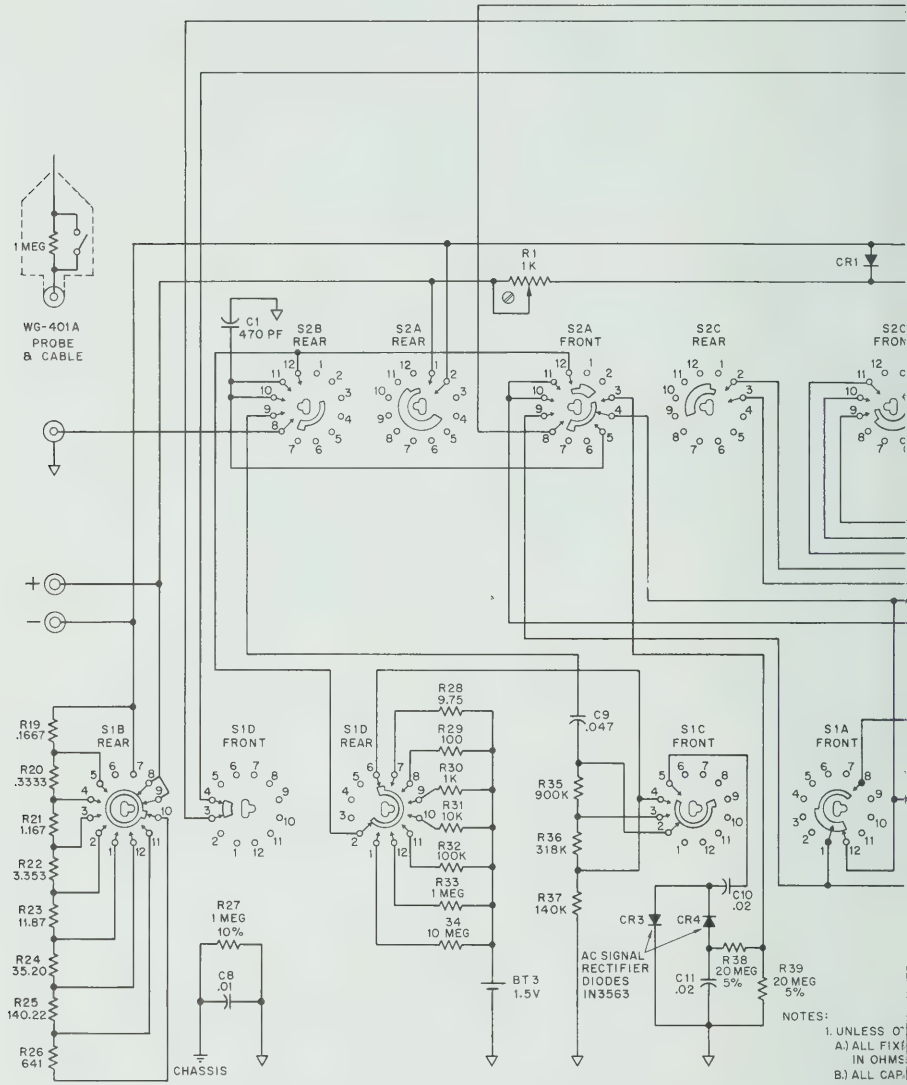
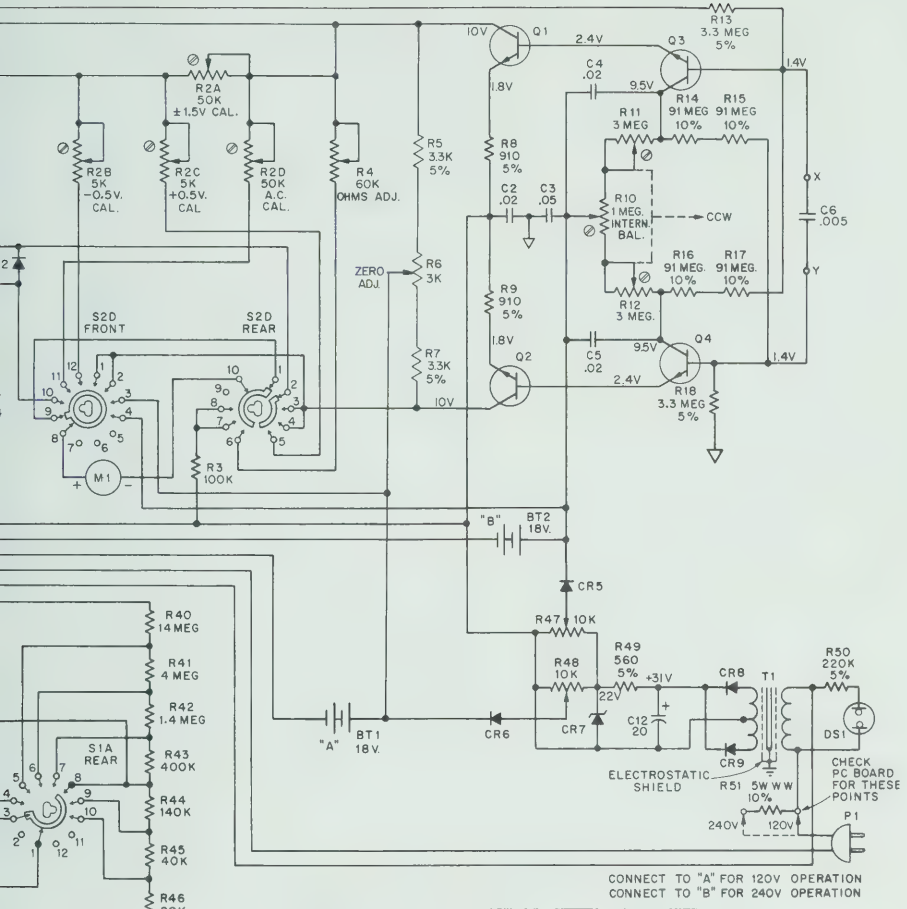


Figure 6. Circuit for resistance measurements above 1000 megohms



FOR UNITS WITH SERIAL NOS. ABOVE 5000

WV-510A Sch



POSITION	S1 RANGE SW.			S2 FUNCTION SW
A (CCW)	0.5V/mA DC ONLY			OFF
B	1.5V/DC mA	Rx1	4	CURRENT
C	5V/DC mA	Rx10	14	AC
D	15V/DC mA	Rx100	40	DC−
E	50V/DC mA	Rx1K	140	DC+
F	150V/DC mA	Rx10K	400	OHMS
G	500V/DC mA	Rx100K	1400	BAT. CHECK "A"
H	1500V/DC mA	Rx1 MEG	4000	BAT. CHECK "B"

WISE STATED:
ESISTOR VALUES ARE
%, CARBON FILM TYPE
R VALUES ARE IN MFD.
REMENTS ARE MADE WITH THE INSTRUMENT
AC OPERATION AND A TVM HAVING 11 MEG
E (SUCH AS THE WV-500B, OR EQUIV.)
ADINGS MAY VARY 10% FROM ONE
ANOTHER.

atic Diagram

Battery Replacement

Four 9-volt batteries are used in the WV-510A. Two of these batteries are designated as "A", and two are designated as "B", as shown in Figure 7. When replacing batteries, always replace both A batteries or both B batteries, as required.

The 1.5-volt battery is soldered in the circuit to assure low-resistance terminal connections. To remove this battery, unsolder the wires connected to the terminals. Before installing a new battery, "tin" (apply a small amount of solder) the terminals. Insert new battery in the same position as the original battery. Solder the red wire to the positive terminal (battery cap) and the black wire to the negative terminal.

When to Replace Batteries

Replace the "A" or "B" set of 9-volt batteries when they no longer test in the green area of the battery test scale.

Replace the 1.5-volt battery only when it is no longer possible to obtain full-scale calibration on the ohms function.

To replace the batteries, remove the case from the unit by taking-out the four screws on the back. Lift up the protective plastic flap and insert the 9-volt batteries into the metal bracket as shown. Snap the connectors onto the battery terminals.

Battery Life

The WV-510A is especially designed to obtain maximum life from the batteries. A constant "trickle" charge is applied to the four 9-volt batteries when the instrument is used on AC power. To extend battery life, the instrument should always be turned off when not in use. Since no warm-up time is required, as with a tube operated

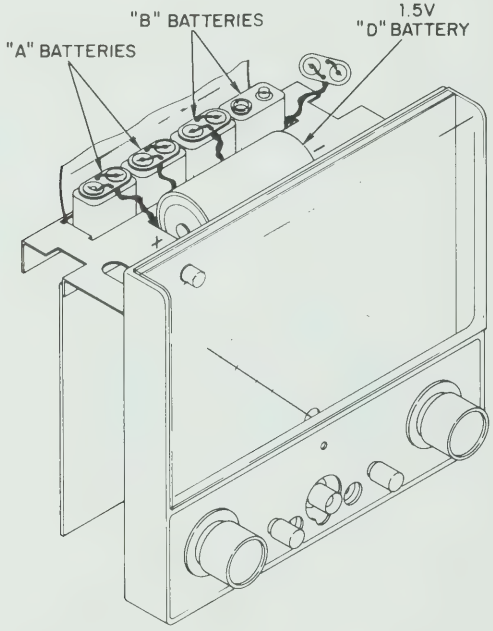


Figure 7. Battery Installation

voltmeter, the WV-510A can be used immediately after being turned on.

Operating and storage temperature is one of the most important factors determining battery life. In general, the life of carbon-zinc batteries such as the VS323 will be decreased as temperature is increased above normal room temperature (70 degrees F). If the instrument is kept in a high temperature area, the batteries will require more frequent replacement.

Low temperature will not have an adverse effect on battery life. On the contrary, battery life will actually be extended. At temperatures below —4 degrees F however, the battery capacity will be reduced, and at temperatures below —22 degrees F, the battery will become inoperative.

Battery Operation Hints

To insure the best performance and longest battery life, it is important that you follow the procedures noted below:

1. The WV-510A will provide a trickle charge to the batteries when it is used on AC (power must be turned on). To maintain the battery charge, it is recommended that as a general rule, the instrument be turned on AC for approximately the same amount of time it is used on batteries.
2. Test the batteries periodically using the battery test function. When in continuous use, test the batteries once a day.
3. If batteries test weak, recharge them by operating the unit on AC for 6 to 8 hours. If the batteries still test weak, replace them (or at least remove them from the instrument) as soon as possible. Shorted or leaky batteries can affect instrument accuracy, even when it is operated from the AC line.
4. Remove the batteries if the instrument is to be stored, or is not to be used for an extended period of time.
5. If you use the instrument on battery operation frequently, in time the two 9V "A" batteries will run down and require recharging or replacement. The two 9V "B" batteries should last much longer, actually the entire period of their useful "shelf life." For this reason, if you remove the batteries temporarily, it is recommended that the "A" and "B" batteries not be mixed. For example, do not take batteries that have been used as "A" batteries, then at a later date reinstall them as "B" batteries.

Accessories

Available on Separate Order

The RCA WG-301A Crystal-Diode Probe may be used with the VoltOhmyst to extend the frequency range to 250 megacycles. This probe circuit consists of a diode rectifier and an RC network. The probe, which slips onto the front of the WG-401A Probe and Cable, eliminates the need for an extra cable.

The WG-301A may be used in RF circuits to measure sine-wave voltage values up to 20 RMS volts in the presence of DC voltage as high as 250 volts. The over-all frequency range of the probe is from 50 kHz to 250 MHz. All RF voltages are read from the DC scales in terms of RMS volts for sine waves. For example: A reading of 5 volts DC indicates that the sine wave being measured has an RMS value of 5 volts. The over-all accuracy of the WV-510A when used with the WG-301A is ±10%.

The RCA WG-411A High-Voltage Probe may be used to measure DC voltages as high as 50,000 volts. The probe uses the WG-436A Multiplier Resistor, having a value of 2079 megohms, to present an over-all voltmeter input resistance of 2100 megohms. With a multiplying factor of 100, the VoltOhmyst provides six full-scale positions of 150, 500, 1500, 5000, 15,000, and 50,000 volts. Do not measure voltages higher than 50,000 volts, because the maximum voltage rating of the probe may be exceeded. The extremely high impedance of the WG-411A is especially desirable when it is necessary to measure voltages found in phototubes, geiger-counter tubes, television, and other high-impedance circuits which would not function properly if loaded down by a low-impedance voltmeter. The WG-411A High-Voltage Probe offers distinct advantages in high-voltage circuits as well as low-voltage circuits characterized by high impedance or poor regulation.

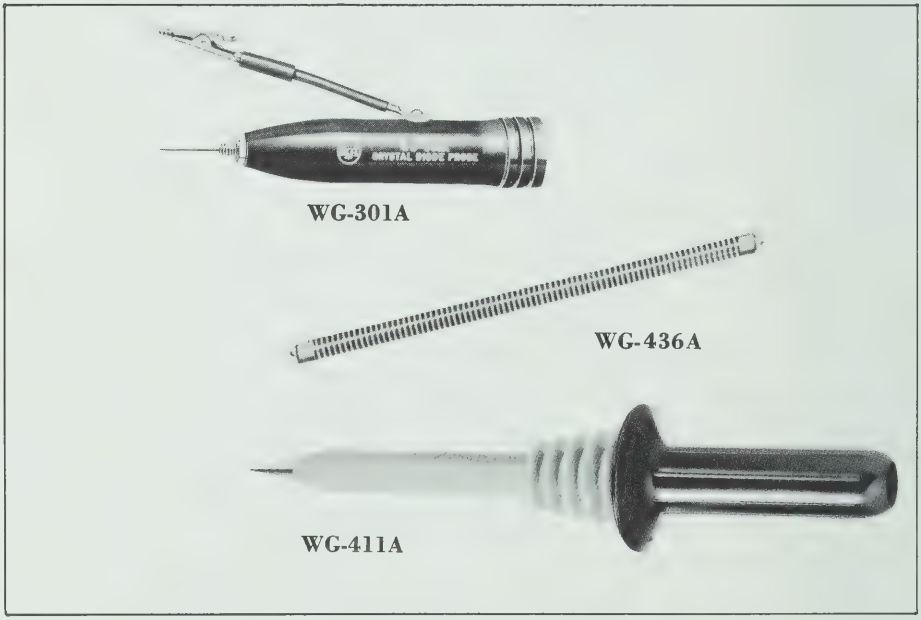


Figure 8. Accessories available for WV-510A

Circuit Description

The operation of the WV-510A Solid-State Master VoltOhmyst is based on a four-transistor amplifier circuit, especially designed for high input impedance with good stability and linearity.

Power Supply

The WV-510A can be operated either from an AC power line or from internal batteries. On AC operation, the voltage is applied through the power transformer, then rectified by diodes CR8 and CR9. A zener diode, CR7, regulates the power supply output so that varying line voltage will not cause zero shift. Diodes CR5 and CR6 isolate batteries BT1 and BT2 preventing them from discharging through the power supply circuit.

For battery operation, four 9-volt batteries must be installed. Two of these are used as BT1 (designated "A") providing 18 volts to operate transistors Q1 and Q2. The other two 9-volt batteries are used as BT2 (designated "B"), and provide bias voltage for Q3 and Q4.

When the unit is used on AC power, the 9-volt batteries receive a constant "trickle" charge. The charge level is established by adjusting potentiometers R47 and R48.

Metering Circuit

The input voltage (from the AC/DC voltage divider or ohms divider) is applied across the bases of Q3 and Q4, positive to Q3 base and negative to Q4 base. These transistors provide a nearly infinite impedance. This high impedance is achieved through a controlled positive feedback network, R14, R15 and R16, R17 and the two impedance adjust potentiometers, R11 and R12. Q3 and Q4 serve as preamplifiers driving the bases of Q1 and Q2. In effect, transistors Q3 and Q1 amplify the positive portion of the signal, and Q4 and Q2 amplify the negative portion of the signal.

Negative feedback through R8 and R9 result in high impedance at the Q1 and Q2 bases to prevent loading the Q3 and Q4 emitters. The output of Q1 and Q2 drive the meter movement.

Potentiometer R10 is used to balance the Q3/Q4 input. This is a factory adjustment and need not be readjusted unless the transistors are replaced. The front panel ZERO control, R6 balances the amplifier output with no input signal applied.

Resistors R13 and R18 serve to isolate and protect the amplifier circuit. Capacitors C2 through C6 are by-pass capacitors to prevent AC signals from affecting the metering circuit.

DC Voltage Function

DC voltage input is applied through the isolation resistor in the probe to the voltage divider network (range), resistors R40 through R46. The voltage from the divider network is then connected to the transistorized metering circuit.

DC Current Function

The transistor amplifier is not used in the DC current function. A separate shunt resistor (R19 through R26) is connected across the meter for each of the current ranges. The current input is connected directly to the meter and shunt circuit. Potentiometer R1 is used to calibrate the current measuring function. Diodes CR1 and CR2 are connected across the meter terminals in the current function to prevent meter damage due to accidental overload.

AC Function

When the VoltOhmyst is used to measure AC voltage, the signal is first rectified by diodes CR3 and CR4 which form a full wave peak-to-peak rectifier. The circuit components are chosen to provide a long time constant. When the signal swings negative, C10 is charged through CR3 to the negative peak value of the voltage. As the input signal

starts in a positive direction, C11 charges to a value equal to the sum of the positive and negative peaks. Because of the relative time constant, the voltage across C11 will be maintained at the peak-to-peak value of the AC signal. This signal, now DC, is fed through the voltage divider network to the metering circuit.

Resistance Function

The voltage from battery BT3, 1.5 volts, is applied through the selected ohms divider resistor (R28 through R34) to the external resistance under test. A voltage divider is formed by the range resistor and the external resistance. The output of this divider is fed to the metering circuit.

Battery Test

There are two battery test positions on the WV-510A; one for battery group "A" (BT1) and one for battery group "B" (BT2). In each of the battery test positions, the batteries operating under their normal load are connected to the meter movement through resistor R3.

Maintenance

The WV-510A is manufactured, tested, and calibrated under strict engineering supervision. Should the instrument require adjustment or repair, the procedure outlined below should be followed. If it becomes necessary to replace any of the component parts, only RCA replacement parts, or their equivalent should be used. Order parts through an authorized RCA Parts & Accessories Distributor.

The schematic diagram for the instrument is on page 16, the Replacement Parts List is on page 28. To service the instrument, take out the four screws in the back and remove the case. To remove meter and case-front assembly, take off the two screws fastening the upper chassis to the case-front, and the nuts on the front panel switches and potentiometers.

240 Volt Operation

The WV-510A can be used on 240 volt AC by re-connecting one lead as described below:

Refer to Figure 11. Unsolder the lead connected to hole #1 in the circuit board. Insert the lead in hole #3. Solder the connection.

Mechanical Zero Adjustment:

The meter pointer should rest at the left-hand zero mark when the function switch is turned to the "OFF" position. If the pointer should come to rest at a deflected position, the position may be corrected mechanically as follows:

CAUTION: Extreme care must be taken in the next step to prevent insertion of the tool to a depth which will injure the pointer spring. The meter warranty does not cover such damage.

Insert a scriber or similar tool to engage the zero-adjustment lever, and move the lever laterally as required to bring the pointer to "0".

Anti-static treatment: The clear plastic meter case has been factory-treated to prevent static charges from forming on the case. If the meter pointer is "sticky" and acts erratically, the anti-static treatment may no longer be effective. Check meter by rubbing the outside surface of the case vigorously with a soft, dry cloth. If the pointer moves away from its original position and remains at another position for several minutes, the case should be re-treated. To restore the anti-static coating, apply a small amount of liquid detergent (the type used in washing dishes) to a soft cloth and gently wipe the front of the meter case.

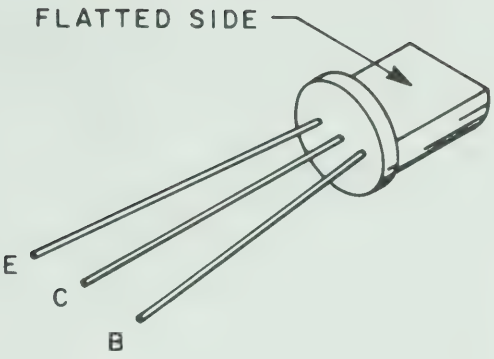


Figure 9. Transistor lead identification

Transistor Replacement

The four transistors used in the WV-510A are specially selected and matched. Should transistor replacement become necessary, all four transistors must be replaced with a matched group. A set of four matched transistors, properly selected and matched, are available from RCA as one stock number. See Parts List, page 28.

CALIBRATION

The internal calibration adjustments of the WV-510A require recalibration only if the transistors or other major circuit components are replaced.

Note: The accuracy of the recalibrated instrument cannot exceed the accuracy of the voltage sources that are used.

Internal Balance Adjustment

1. Check the mechanical zero position of the pointer. If necessary, reset mechanical zero as described on page 22.
2. Temporarily connect a jumper wire between Q3 base and Q4 base.
3. Turn function switch to "−DC VOLTS" and range switch to "0.5V DC". Adjust ZERO control to bring meter pointer exactly to "0". Check for correct zero setting by switching function switch from "+DC VOLTS" to "−DC VOLTS"; the pointer should not shift. Remove jumper wire.
4. Set the function switch to the +DC position. Adjust R10, the "INT BAL" control to bring the meter pointer to "0". Again, check for correct adjustment by switching the function switch from "+DC VOLTS" to "−DC VOLTS"; the pointer should not shift.

Input Impedance Adjustment

1. Set function switch to "R OHMS", and the range switch to "R x 1". Adjust "OHMS" control for exactly full scale reading.
2. Set range switch to "R x 1 MEG". If meter drops below "1000" on the OHMS scale, simultaneously adjust both "IMPED. ADJ" potentiometers, R11 and R12 for a full scale meter reading.
3. Repeat Internal Balance Adjustment above.

DC Voltage Calibration

1. Turn the function switch to "+DC VOLTS", the range switch to "0.5V DC", and the probe switch to "DC". Adjust ZERO control to bring meter pointer exactly to "0".
2. Turn the range switch to "0.5 V DC". Apply +0.5 volts from a precision voltage source to the probe and

ground lead. Adjust R2C, the "+.5" control to bring the meter pointer to the full scale mark on the 0-to-5.0 scale.

3. Set function switch to "−DC VOLTS", and reverse test lead connection to voltage source so that −0.5 volts DC is applied. Adjust R2B, the "−0.5V" calibrate control to bring the meter pointer to the full scale mark on the 0-to-5.0 scale.
4. Connect the output of a precision 1.5-volt DC voltage source to the probe and ground lead. Adjust R2A, the DC CAL control to bring the meter pointer exactly to the full scale "15" mark on the 0-to-15 scale.

DC Current Calibration

1. Set the function switch to "DC CURRENT" and the range switch to "0.5V/mA".
2. Apply 0.5 mA to "+mA" and "−mA" test leads with proper polarity. Adjust potentiometer R1 (located on range switch), to bring the meter pointer to exactly the full scale "5.0" mark on the 0-to-0.5 scale.

AC Calibration

1. Set the function switch to "AC", the range switch to "50V", and the probe switch to "AC/OHMS". Adjust ZERO control to bring meter pointer exactly to "0".
2. Connect the ground lead and probe to an AC voltage source of 50 volts (RMS). Adjust R2D, the "AC CAL" control to bring the meter pointer exactly to the full-scale "5.0" mark on the 0-to-5.0 scale.

Battery Charge Adjustment

1. Unplug the AC power cord, and remove the four 9-volt batteries. Connect a jumper wire between lugs #2 and #3 on wafer C of S-2, the function switch. These lugs can be identified by noting that the wires connected to them lead to the AC plug in the rear of the instrument.
2. Plug in the AC power cord, and set the function switch to the "BATT TEST A" position. Use a variac to adjust line voltage to 120 volts. Adjust R48 (located closest to transformer) so that the meter reads 4.7 on the 5.0 DC scale. (This actually corresponds to 18.8V DC).
3. Set the function switch to the "BATT TEST B" position. Adjust R47 (located near 4-section pot) so that the meter reads 4.7 on the 5.0 DC scale.

   Remove jumper wire.

   Replace batteries.

Troubleshooting Hints

Instrument fails to operate on all functions.

9-volt batteries dead.
Probe defective. Check continuity.

Voltage readings low on battery operation, especially at right-hand side of meter scale.

9-volt batteries require replacement.

Meter cannot be adjusted full-scale on ohms function.

1.5-volt battery weak.

Instrument cannot be zeroed on any voltage function.

Check transistor amplifier circuit.

Meter pointer bangs hard left or right, depending on function switch setting.

Open or short circuit in amplifier metering circuit.

Meter pointer sticks, or is sluggish on all functions.

Meter movement defective.

Instrument fails to indicate properly on any AC voltage range; operates normally on DC volts and ohms.

Diodes CR3 or CR4 defective.
C1, C10, C11, R35 to R37 defective.

Instrument inaccurate on 500 and 1500 volt AC ranges.

Resistors R35, R36, or R37 defective.

Instrument inaccurate on any AC or DC voltage range. Ohms OK.

Check voltage divider resistors, R40 through R46.

Resistance readings inaccurate.

Check resistors R28 through R34.
Poor connection to 1.5-volt battery.
High internal resistance in battery.

Instrument inaccurate or inoperative on current ranges only.

Check resistors R19 through R26.

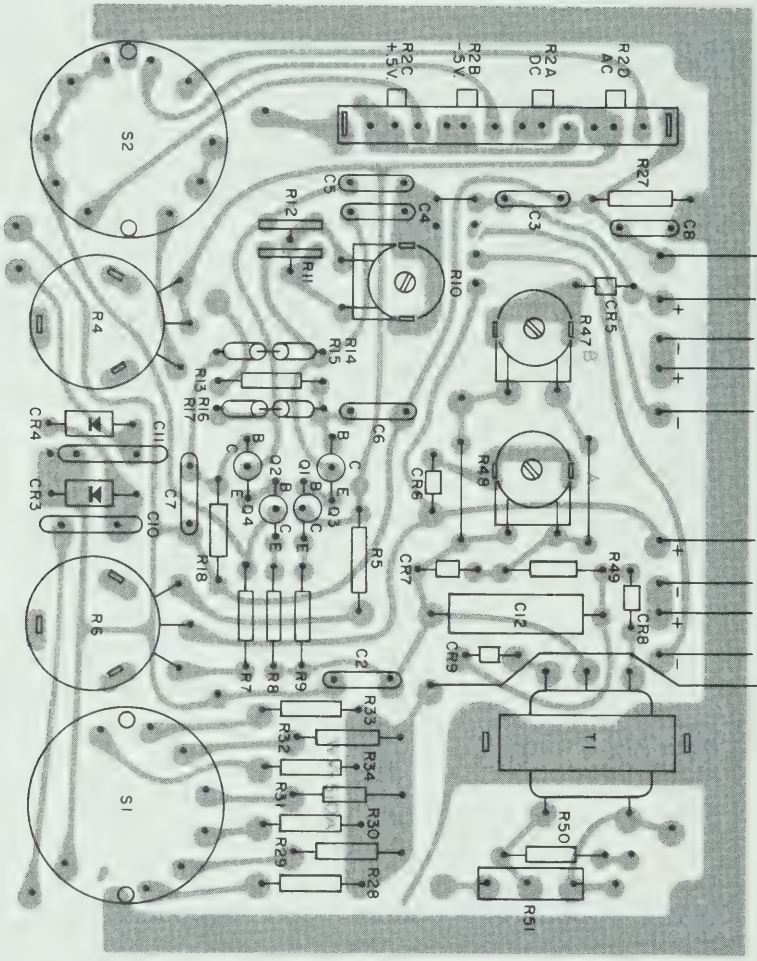


Figure 10. Circuit board component layout. View from foil side

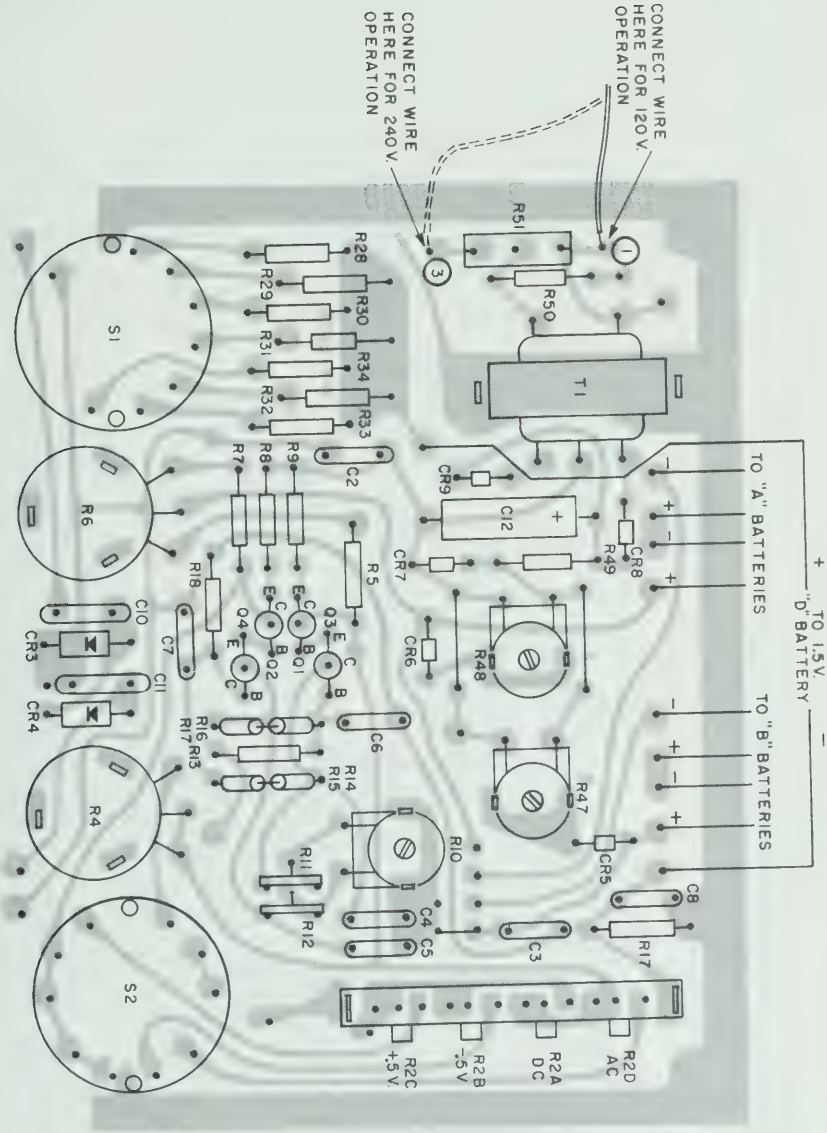


Figure 11. Circuit board component layout. View from component side

Replacement Parts List

WV-510A Master VoltOhmyst

When ordering replacement parts, include the stock number and description of the part, as well as the serial number and code number of instrument. Parts should be ordered through a local RCA parts and accessories distributor.

Symbol	Description	Stock No.
	Capacitors	
C1	Ceramic Disc, 470 PF 20% 1500 V	248589
C2	Ceramic Disc, .02 MF 20% 600 V	210685
C3	Ceramic Disc, .05 MF 500 V	424029
C4, C5	Ceramic Disc, .02 MF 20% 600 V	210685
C6*	Ceramic Disc, .005 MF 20% 600 V	424028
C7,* C8	Ceramic Disc, .01 MF 20% 600 V	211723
C9	Paper, .047 MF 10% 400 V	227754
C10, C11	Ceramic Disc, .02 MF 20% 1000 V	231326
C12	Electrolytic, 20 MF 50 V	240305
	Resistors	
R1	Variable, Wirewound, 1000 OHMS 30% 1 W	248615
R2	Variable, Quad Pot, 50K, 5K, 5K, 50K	248614
R3	Film, 100K, 1%, ½ W	237540
R4†	Variable, 60K "OHMS"	420129
R5†	Film, 3300 OHMS, 5%, ½ W	133463
R6†	Variable, 3000 OHMS "ZERO"	420130
R7†	Film, 3300 OHMS, 5%, ½ W	133463
R8, R9	Film, 910 OHMS, 5%, ½ W	228914
R10	Variable, 1 MEGOHM, 30%, ¼ W	248611
R11, R12	Variable, 3 MEGOHM, 30%, ¼ W	245902
R13	Film, 3.3 MEGOHM, 5%, ½ W	243005
R14 to R17	91 MEGOHM, 10%, ½ W	248610
R18	Film, 3.3 MEGOHM, 5%, ½ W	243005
R19	Wirewound, 0.1667 OHMS, 1%, ½ W	248597
R20	Wirewound, 0.3333 OHMS, 1%, ½ W	248599
R21	Wirewound, 1.167 OHMS, 1%, ½ W	248598
R22	Wirewound, 3.353 OHMS, 1%, ½ W	248609
R23	Film, 11.87 OHMS, 1%, ½ W	248608
R24	Film, 35.20 OHMS, 1%, ½ W	248607
R25	Film, 140.2 OHMS, 1%, ½ W	248606
R26	Film, 641 OHMS, 1%, ½ W	248605
R27	Film, 1 MEGOHM, 10%, ½ W	243004
R28	Film, 9.75 OHMS, 1%, ½ W	242147
R29	Film, 100 OHMS, 1%, ½ W	237414
R30	Film, 1000 OHMS, 1%, ½ W	236062
R31	Film, 10K, 1%, ½ W	236087
R32	Film, 100K, 1%, ½ W	237540
R33	Film, 1 MEGOHM, 1%, ½ W	247716

*C7 used only in units with serial numbers below 5000.
†In units with serial numbers below 5000:
R4 is 75K, stock #248613
R5 is 2200, stock #228712
R6 is 5K, stock #248612
R7 is 2200, stock #228712

Symbol	Description	Stock No.
R34	Film, 10 MEGOHM, 1%, ½ W	248604
R35	Film, 900K, 1%, 1 W	242146
R36	Film, 318K, 1%, ½ W	243003
R37	Film, 140K, 1%, ½ W	099318
R38, R39	Film, 20 MEGOHM, 5%, ½ W	242142
R40	Film, 14 MEGOHM, 1%, ½ W	248603
R41	Film, 4 MEGOHM, 1%, ½ W	248602
R42	Film, 1.4 MEGOHM, 1%, ½ W	248601
R43	Film, 400K, 1%, ½ W	055862
R44	Film, 140K, 1%, ½ W	099318
R45	Film, 40K, 1%, ½ W	248600
R46	Film, 20K, 1%, ½ W	236777
R47, R48	Variable, 10,000 OHMS, 30%, ¼ W	248094
R49	Film, 560 OHMS, 5%, ½ W	224252
R50	Film, 220K, 5%, ½ W	237000
R51	Wirewound, 5600 OHMS, 10%, 5 W	120081
	Semiconductors	
Q1 to Q4	Transistor, Type 2N5232 (set of 4)	248619
CR1, CR2	Diode, Type 1N914A	239164
CR3, CR4	Diode, Type 1N3563/1N4007	242141
CR5, CR6	Diode, Type 1N4002	234761
CR7	Diode, Type 1N969A	248592
CR8, CR9	Diode, Type 1N4002	234761
	Miscellaneous	
DS1	Lamp, Neon	048474
M1	Meter	248594
S1	Switch, Range	248616
S2	Switch, Function	248617
T1	Transformer	248618
	Alligator Clip	035262
	Case, Front	248590
	Case, Rear	249528
	Handle, Leather	210093
	Insulating Boot	099539
	Jack, Banana, Red	230283
	Jack, Banana, Black	225222
	Knob, Plastic	227050
	Knob, Rubber	094878
	Meter Cover, Clear Plastic	210287
	Panel, Aluminum	248595
	Printed Circuit Board	248591
	Post	248596
	Power Cord	420635
	Receptical, AC Cord	74594
	Test Leads (for current meas.)	
	Red	245597
	Black	245596

RCA Repair Service

Authorized RCA Service Depots throughout the United States are available for repair and calibration of RCA Electronic Instruments. For up-to-date listings of these Depots, contact your RCA Distributor, or write to RCA Electronic Instruments, 415 South 5th Street, Harrison, New Jersey 07029.

If it becomes necessary to service this equipment, fill out one of the Test Equipment Service order forms supplied with the instrument. It is important that:

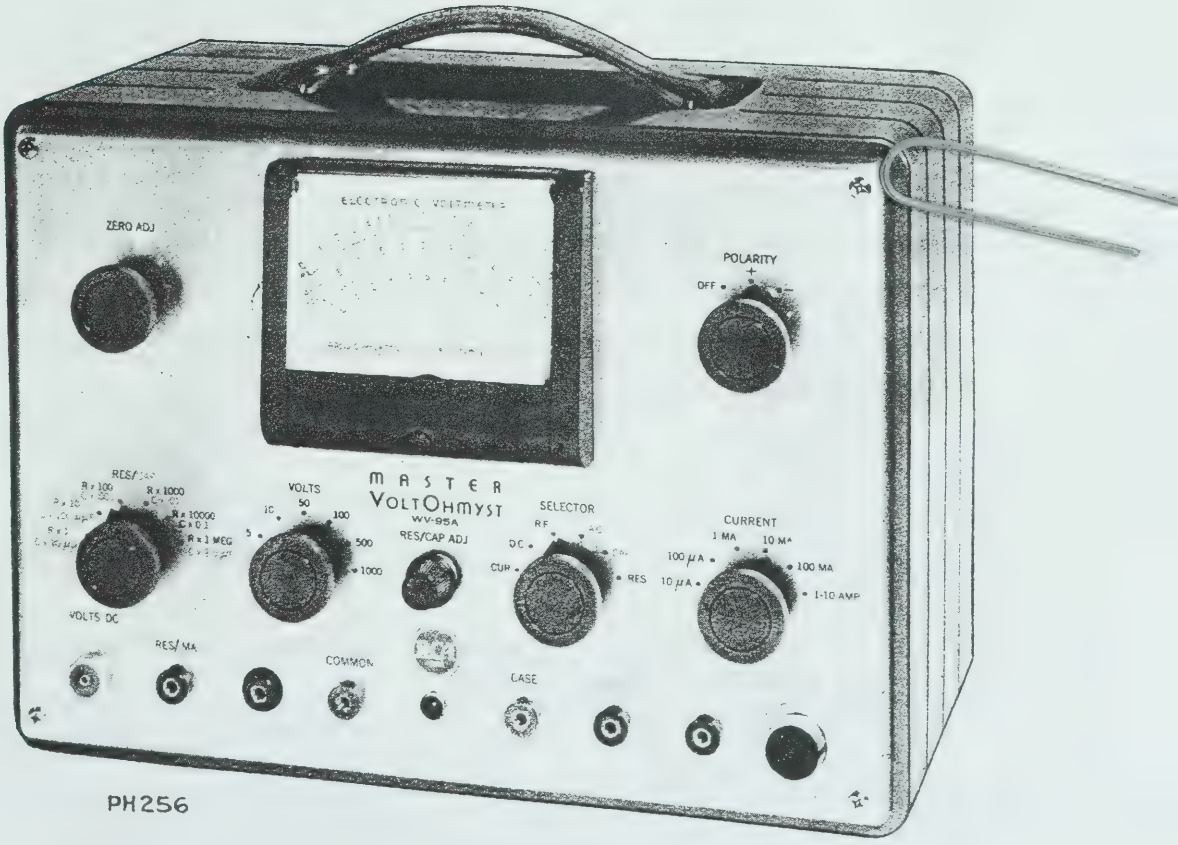
1. Test equipment be packed carefully. The instrument should be double-packed. It is best to pack the unit in its original carton, or similar container, then "float" this carton in at least a 3-inch layer of shredded paper inside the outer carton.
2. A full description of the trouble be included in the report.
3. All probes, cables, and test leads used with the equipment be included in the shipment.

Attention to these details will help prevent damage in transit and delay in repairs.

RCA

MASTER VOLTOHMYST

TYPE WV-95A



PH256

TEST AND MEASURING EQUIPMENT SECTION
RADIO CORPORATION OF AMERICA
CAMDEN, NEW JERSEY, U.S.A.

IB-4095-1

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IMPORTANT

THIS INSTRUMENT IS SHIPPED WITHOUT BATTERIES. REFER TO THE INSTRUCTIONS ON PAGE 10 FOR THEIR INSERTION.

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MASTER VOLTOHMYST

TYPE WV-95A

TECHNICAL SUMMARY

Electrical Characteristics

D-C VOLTMETER

Ranges .....0 to 5-10-50-100-500-1000 volts.

Input resistance ....11 megohms for all ranges —includes 1 megohm in probe.

Sensitivity (max.) ..2.2 megohms per volt on 5-volt range.

Circuit .....Differential degenerative vacuum-tube bridge.

D-C AMMETER

Ranges .....0 to 10-100 microamperes, 0 to 1-10-100 milliamperes using d-c amplifier; 0 to 1-10 amperes direct to meter.

OHMMETER

Ranges .....0.1 ohm to 1000 megohms in 6 ranges.

A-C VOLTMETER (AUDIO FREQUENCY)

Ranges .....0 to 1-5-10-50-100-500-1000 volts rms.

Input impedance (with cable) .....Approx. 5 megohms resistance shunted with approx. 125 mmfd. capacity.

Frequency response..Flat from 30 to 20,000 cycles.

Circuit .....A-f feedback amplifier and balanced linear diode with d-c bridge amplifier.

CAPACITY METER

Ranges .....4 mmfd. to 1000 mfd. in 6 ranges.

Polarizing voltage ..50 volts d.c. available on high-capacity range.

MULTIPLIERS

Accuracy .....±1% matched pair, aged resistors.

INDICATING METER

Sensitivity .....200 microamperes (full-scale).

Accuracy .....±2% of full-scale indication.

TUBE COMPLEMENT

2 RCA 6AK6 .....Vacuum-tube bridge.
1 RCA 6AL5 .....Diode.
1 RCA 6AU6 .....Audio amplifier.
1 RCA 6X4 .....Rectifier.

POWER SUPPLY

Voltage rating .....105-125 volts, 50-60 cycles (specifications are based on 117 volts, 60 cycles).

Power consumption..15 watts.

Battery for ohmmeter circuit .....Two 1.5-volt flashlight cells (RCA VS006 or equivalent).

ACCESSORIES (Available but not supplied as part of the WV-95A)

RCA Diode Probe (MI-8275) .....For r-f measurements up to 100 volts rms and at frequencies to 250 mc.

RCA Crystal Probe (MI-8263) .....For r-f measurements at frequencies up to 250 mc and at potentials not exceeding 20 volts positive peak in which a very low input capacity is required.

Mechanical Characteristics

Overall Dimensions..Height, 9⅞″; width; 13¾″; depth, 7½″.

Weight .....15 lbs.

Finish .....Blue-grey hammeroid case with anodized satin aluminum panels.

GENERAL DESCRIPTION

The Master VoltOhmyst, Type WV-95A, is an electronic meter designed to measure resistance, capacitance, direct current, d-c voltage, and a-c voltage (audio frequency and radio frequency) over extremely wide ranges. Outstanding features of the instrument are: ease of operation; isolated measuring circuit for reading up to 1000 volts d-c or 230 volts rms (a-c) above ground; high input resistance; automatic protection of the indicating meter against burnout; simplicity of meter scales; "Zero Adjust" that does not have to be reset when ranges are changed; a zero-center scale for use in

aligning f-m and a-f-c discriminator circuits; and provision for the use of the RCA Diode Probe or the RCA Crystal Probe to measure r-f voltages up to 250 megacycles.

The principal part of this instrument consists of two RCA 6AK6 miniature tubes in a push-pull d-c vacuum-tube voltmeter circuit which is characterized by excellent linearity and stability. Both tubes are coupled to a common, high-value bias resistor. The control grid of one of the tubes is permanently grounded, and the voltage to be measured is applied to the grid of the other tube. This voltage is always a d-c voltage; moreover, it is proportional to the magnitude of the quantity being measured. For instance, variations in the values of resistances or capacitances being measured are converted to corresponding variations in the value of the d-c voltage applied to the vacuum-tube bridge. Because of the common cathode coupling, any change in the voltage applied to the grid of one tube produces a change in the cathode bias of the other. As a result, the change in plate current of one tube is accompanied by a simultaneous opposite change in the plate current of the other. The differential voltage developed across the plate load resistors by the plate current is applied, through a polarity-reversing switch, to the meter, which is calibrated in direct current, d-c volts, a-c volts, resistance, and capacity.

Audio-frequency voltage to be measured is passed through a range attenuator to an RCA-6AU6 audio amplifier. The use of feedback in this circuit results in a linear amplifier with good stability and high input impedance. The amplified a-c voltage is applied to an RCA-6AL5 diode rectifier, which furnishes the vacuum-tube bridge with a d-c voltage proportional to the positive-peak value of the measured a-c voltage. The meter scale is calibrated in r-m-s values of a sine wave.

Direct current, on all but the 1- and 10- amp ranges, is measured by passing the current through suitable shunts, and utilizing the resulting voltage drop to drive the vacuum-tube bridge. On the 1- and 10-amp ranges, the current is passed directly through the indicating meter and a low-impedance meter shunt. This is done to keep the instrument from introducing an excessive voltage drop into low-voltage circuits where high-current measurement might be required.

Radio-frequency voltages can be measured when the RCA Diode Probe is used with the Master VoltOhmyst. This probe, which is stocked as MI-8275, is available on separate order. Also available for this purpose is the RCA Crystal Probe, MI-8263.

A special circuit is used to measure capacity over wide ranges with a single meter scale. The unknown capacity is connected in series with a capacity standard and a 0.01- mfd. capacitor. Across the series combination is applied a 60-cycle voltage of proper magnitude. This 60-cycle voltage is distributed across the capacitors in the series circuit in proportion to their reactances at this frequency. The drop across the 0.01-mfd capacitor is measured by means of the audio amplifier and diode circuits, and the resulting meter deflection is read on a meter scale calibrated directly in mfd, or mmfd., according to the range in use. Polarizing voltage from the d-c power supply is applied through a 100,000-ohm resistor to the capacity test jacks on the highest-capacity range. By means of this polarizing voltage, electrolytic capacitors may be measured with d-c voltage applied.

An RCA-6X4 miniature rectifier is employed to supply the d-c voltages required by the Master VoltOhmyst. The power transformer is of special design, having in addition to plate and filament windings, a special winding which supplies the a-c voltages required by the capacity-measuring circuit. This special winding is shielded by three electrostatic shields, two of which are ungrounded.

The low side of the measuring circuit is isolated from the chassis, and a separate case ground terminal is provided. This allows measurements to be made in circuits where both meter leads will be above ground potential. Under this condition the Master VoltOhmyst case alone can be grounded for safety reasons.

HOW TO USE THE RCA MASTER VOLTOHMYST

SAFETY PRECAUTIONS

HIGH VOLTAGES ARE DANGEROUS! For your personal safety, the following precautions should be observed while you are working around high-voltage equipment:

a. Avoid working alone when possible. Serious consequences of electrical shock can be avoided by the presence of a second person to remove power and apply resuscitation when necessary.

b. Avoid contact with or even close proximity to high-voltage points. If you are not familiar with the equipment, find out where high-voltage points exist before proceeding with measurements.

c. If possible, when making high-voltage measurements, remove the voltage from the circuit under test while attaching the meter leads.

d. If it is impracticable to turn the power off during measurements, the following precautions are recommended:

1. Connect the CASE terminal of the instrument to a good ground.
2. Make sure that the clip on the lead from the COMMON terminal is securely attached to the low side of the voltage to be measured. Use of the RCA Binding Post Pin Plugs will prevent the test leads from becoming detached from the Volt-Ohmyst case.
3. Keep your fingers well away from the probe tip.
4. Avoid contact between any part of your body and ground. If the floor is not insulated, find some dry insulating material to stand on. Do not lean against or rest your free hand on an equipment rack, a metal bulkhead or anything else providing a ground return.

e. Do not use leads with defective insulation.

f. Never leave the meter connected to a high-voltage point after measurements have been completed.

g. Do not depend on immediate removal of voltage from high-voltage circuits when the main power switch is opened. Sometimes filter capacitors will retain sufficient charge to cause serious injury. In cases where high voltage is supplied by a motor-generator set, the main switch may turn off only the motor power, so that voltage will be present until the machine stops.

h. DO NOT CONNECT THE CASE TERMINAL OF THE MASTER VOLTOHMYST TO A HIGH-VOLTAGE POINT!!! Failure to observe this precaution may result in a severe shock, since the CASE terminal connects directly to the metal case of the instrument.

PRELIMINARY ADJUSTMENT

Connect as required, the blue lead to the terminal marked VOLTS DC, one of the black leads to the COMMON terminal, the red lead to the RES/MA terminal, and the red probe lead to the VOLTS AC terminal. Before turning the instrument on, check the zero setting of the meter pointer. If the pointer is not on zero, refer to the instructions under "Maintenance" for setting the meter pointer.

Plug the power cord into a 117-volt, a-c supply, and adjust the controls as follows:

POLARITY—Set to "+" or "—" (this switch applies power to the instrument)

SELECTOR—Turn to "DC".

ZERO ADJ—Set so that the meter pointer reads zero on all scales.

SELECTOR—Turn to "RES" (the pointer should deflect to approximately full scale)

RES/CAP ADJ—Set so that the meter pointer reads exactly to the last line on the "R" scale.

The instrument is now ready for use in the measurement of resistance, direct current, d-c voltage, and audio- and radio-frequency voltage.

NOTE—When accurate readings are required, the instrument should be allowed to warm up for at least ten minutes before the adjustments described above are made.

OPERATION

-C Voltage Measurements—The d-c voltmeter nas six ranges: 0 to 5, 10, 50, 100, 500, and 1000 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two center d-c voltage scales. The d-c voltmeter will not read when the VOLTS switch is set on "1"; therefore, this position of the switch is never used when d-c voltages are being measured. For d-c voltage measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "DC".

VOLTS—Select a range including the value of the voltage to be measured.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured (see Safety Precautions).

DC VOLTS—Connect or touch the d-c probe (blue lead) to the high side of the voltage to be measured.

NOTE—When high voltages are to be measured, connect the CASE terminal of the instrument to a good ground, such as a cold-water pipe.

Zero-Center Application—Provisions have been made to shift the d-c zero reading to the center of the scale when it is desirable to observe the d-c voltage variation around zero volts. Both positive and negative voltage excursions can be observed

without resetting the POLARITY switch each time the polarity of the voltage changes.

To use the zero-center feature of the Master VoltOhmyst, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+ ".

SELECTOR—Set on "DC".

ZERO ADJ—Set so that the meter pointer is directly over the "0" mark at the center of the meter scale.

VOLTS—Set to the desired voltage range.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured.

VOLTS DC—Connect or touch the d-c probe (blue lead) to the high side of the voltage to be measured.

Direct Current Measurements—The direct-current meter has seven ranges: 0 to 10, 100 microamperes; 0 to 1, 10, 100 milliamperes; and 0 to 1, 10 amperes. When the proper range has been selected on the CURRENT switch, the current may be read directly from the direct-current scale.

For direct-current measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "CUR".

CURRENT—Select a range including the value of the current to be measured.

Terminal Connections:

COMMON—Connect the black clip-lead into circuit so that the current to be measured must flow through this lead.

RES/MA—If the current to be measured is less than 100 ma, connect the red lead between this terminal and the other side of the circuit.

1 AMP—If the current to be measured is between 100 ma and 1 amp, connect the red lead to this terminal.

10 AMP—If the current to be measured is between 1 amp and 10 amps, connect the red lead to this terminal.

CAUTION—In the "1-10 AMP" position of the CURRENT switch, the measured current flows directly through the indicating meter, so that the anti-meter-burnout feature of the Master VoltOhmyst is not effective. Reasonable precautions should be taken to prevent meter burnout when the "1-10 AMP" setting of the CURRENT switch is employed.

NOTE—The zero-center feature of the instrument is also available when metering direct current. The procedure is analagous to that described under "Zero Center Applications," except, of course, the SELECTOR switch is set on "CUR," and the CURRENT switch is used to select the proper ranges.

Audio-Frequency Voltage Measurements—The a-c (audio-frequency) voltmeter has seven ranges: 0 to 1, 5, 10, 50, 100, 500, and 1000 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two center scales. If the a-c voltage is a sine wave, then the voltage is read from the meter scale as the r-m-s value. If the voltage is not a sine wave, then the meter reading, when multiplied by 1.414, will give the positive-peak value of the voltage.

For audio-frequency voltage measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "AC".

VOLTS—Select a range including the value of the voltage to be measured. If the ZERO ADJ control has been previously set as described under "Preliminary Adjustments," then, when the VOLTS switch is on "1," the meter pointer will be automatically aligned with the small red zero on the bottom half of the center scale. This zero appears just to the right of the normal zero for that scale, and is the zero which should be used when the VOLTS switch is on "1." If the pointer does not automatically read to this zero, then the AC ZERO control inside the case should be adjusted as described in the Maintenance section of this book. For all other positions of the VOLTS switch, the black zero is used.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured.

VOLTS AC—Connect or touch the a-c probe (red lead with 4-prong plug) to the high side of the voltage to be measured.

Radio-Frequency Voltage Measurements— For this application, the RCA Diode Probe or Crystal Probe is required. These are not supplied with the Master VoltOhmyst, but are available on separate order. The application of the Diode Probe only will be considered here. Instructions for using the Crystal Probe are furnished with the probe. The r-f voltmeter has four ranges: 0 to 5, 10, 50 and 100 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two bottom red scales on the two lower ranges (0 to 5, 10),

or from one of the two center black scales on the two upper ranges (0 to 50, 100). If the a-c voltage is a sine wave, then the voltage is read from the meter scale as the r-m-s value. If the voltage is not a sine wave, then the meter reading, when multiplied by 2.83, will give the peak-to-peak value of the voltage.

CAUTION—To avoid damage to the probe, refer to the "ACCESSORIES" section of the Specifications and do not exceed the input voltage indicated.

For r-f voltage measurements with the Diode Probe, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "RF". In this position of the switch the pointer will normally deflect to the left, unless the Diode Probe is in its socket.

VOLTS—Select a range including the value of the voltage to be measured. As mentioned before, only the "5", "10", "50", and "100" positions of the VOLTS switch are used in this particular application.

Terminal Connections:

VOLTS AC—For high radio-frequency measurements the center pin of the RCA Diode Probe should be connected directly to the high side of the voltage to be measured, while the knurled ring of the probe should be connected directly to the grounded or low side. The grounding ring is tapped for a ⅝"-24 N.E.F.2 thread, so that the probe will mate with an Amphenol 83-1R connector, a Navy type CPH 49194 connector, an Army type SO-239 connector or any similar type. In cases where direct connection to one of these connectors is impracticable, satisfactory results can be obtained by using a short extension made of coaxial cable.

For low radio-frequency measurements the clips may be used. The large clip screws on the center pin of the probe; the short black clip-lead screws into the tapped hole in the side of the grounding ring.

Measuring A-C (audio or radio frequency) when D-C is Present—When both alternating and direct voltages are present, the a-c component of the voltage can be measured with the Master VoltOhmyst by following the procedure outlined for audio- and radio-frequency measurements. If the d-c component exceeds 600 volts, a one-microfarad (or larger) capacitor of adequate voltage rating should be used in series with the probe input.

Resistance Measurements—Before attempting to measure resistance, see that no voltage exists across the component to be checked. Resistance is read directly in ohms from the upper black scale of the meter.

For resistance measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set to "+" or "–".

SELECTOR—Set to "RES".

RES/CAP—Select a range including the value of the resistance to be measured. It is recommended that the "RX1" position of the RES/CAP switch be used only for resistances below 20 ohms.

RES/CAP ADJ—Set so that the meter pointer is aligned to the last line on the right-hand side of the resistance scale.

Terminal Connections:

COMMON—Connect the black clip-lead to one side of the resistance to be measured.

RES/MA—Connect the red clip-lead to the other side of the resistance.

To cancel the lead-resistance error when making resistance measurements below two ohms, short the test leads together and reset the ZERO ADJ control so that the pointer reads exactly zero. When the low-resistance checks have been completed, the ZERO ADJ control should be reset so that the meter pointer reads zero when the SELECTOR switch is on "DC."

When measuring high resistances, keep the fingers away from the tip of the ohms probe (red lead) to eliminate a possible leakage or stray-pickup error. This is especially important when the "RX10,000" and "RX1 MEG" positions of the RES/CAP switch are employed.

CAUTION—The Master VoltOhmyst applies up to three volts across the resistance being measured when the RES/CAP switch is set to "RX1" or "RX10." When it is necessary to check the continuity or to measure the resistance of a low-resistance device having a small current-carrying capacity, such as the filament of a low-voltage vacuum tube or a thermocouple, then a resistor should be used in series with the ohmmeter leads, or a range above "RX10" should be used.

A periodic check of the battery voltage should be made to insure accurate ohmmeter readings. Refer to the "Maintenance" section for instructions on replacing batteries.

Measuring Resistance Above 1000 Megohms—The Master VoltOhmyst can be used to measure resistances higher than those covered by the "RX1 MEG" setting of the RES/CAP switch. This application is especially useful for the measurement of capacitor or insulation leakage resistance.

The method requires an external voltage source, ranging in value from 20 to 500 volts, to produce

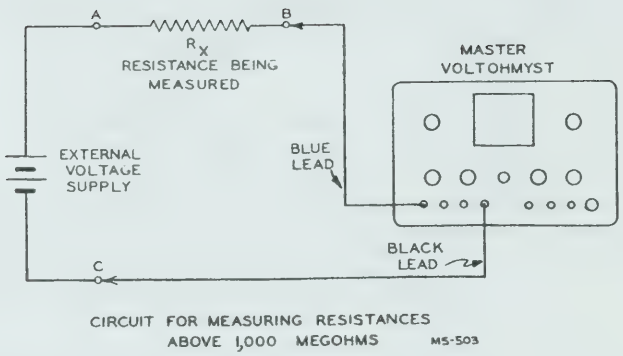

Figure 1

a measureable current through the resistance being checked.

Make the connections portrayed in Figure 1. Set the SELECTOR switch to "DC" and measure the voltage from point "B" to point "C." Then measure the voltage between point "A" and point "C." For accurate measurements, the value of voltage from the external source must be sufficient to produce a readable meter deflection when the meter is connected between "B" and "C." The unknown resistance can be computed from the following formula:

$$\text{Unknown Resistance in megohms} = 11 \times \frac{\text{VOLTS}_{AC} - \text{VOLTS}_{BC}}{\text{VOLTS}_{BC}}$$

Example:

Suppose the voltage between "A" and "C" is 500 volts; the voltage between "B" and "C" is 2 volts.

Then:

$$\text{Unknown resistance} = 11 \times \frac{500 - 2}{2} = 2739 \text{ megohms}$$

Capacity Measurements—The capacity meter has six ranges: CX10 mmf; CX100 mmf; CX.001 mf; CX.01 mf; CX0.1 mf; and CX1.0 mf. When the proper range has been selected on the RES/CAP switch, the capacity can be read directly from the upper red meter scale.

To make capacity measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set to "+" or "−".

SELECTOR—Set to "CAP".

ZERO ADJ—Set so that the meter pointer is aligned with the small red zero on the bottom half of the upper scale. This zero appears just to the right of the zero for the resistance scale.

RES/CAP ADJ—Short circuit the COMMON and CAP terminals, then adjust this control until the meter pointer is aligned with the last mark on the right-hand side of the upper scale.

RES/CAP—Select a range including the value of the capacity to be measured.

Terminal Connections:

CAP—Connect one side of the capacitor to be tested to this terminal.

COMMON—Connect the other side of the capacitor to this terminal.

When the "CX1.0 mf" setting of the RES/CAP switch is employed, a polarizing voltage of 50 volts is applied between the CAP and COMMON terminals. If electrolytic capacitors are to be checked, the positive side of the capacitor should be connected to the CAP terminal, and the negative side to the COMMON terminal.

Since leaky capacitors will give an inaccurate capacity indication, capacitors suspected of leakage should be checked with the ohmmeter section of the instrument to determine whether or not a high-resistance d-c leak exists. Then, if no leak is present, the capacity measurement can be made.

When making measurements on very small capacities (on the order of a few micro-microfarads), the capacitors should be attached to the binding post terminals so that they are positioned as far away from the front panel as possible. Also, all stray matter (test leads, hands, etc.) should be kept away from the capacitor under test while the measurement is being made. It should be remembered that the Master VoltOhmyst measures the actual capacity between the CAP and COMMON terminals, which includes the capacity under test plus any stray capacity. Anything that will minimize the stray capacity will increase the accuracy of the measurement.

SPECIAL APPLICATIONS

The RCA Master VoltOhmyst will be found useful for many applications in the servicing of all types of electronic equipment. Its possible uses in this field are too numerous to be covered in detail in this book. However, several applications which are considered to be of particular interest are described in the following paragraphs:

Measuring Oscillator Strength—The negative d-c voltage developed at the grid of an oscillator is proportional to the strength of oscillation. This voltage can be measured readily with the Master VoltOhmyst. To determine the relative strength of oscillation of a radio-receiver local oscillator at different frequencies, comparative readings should

be taken for each band while the main tuning capacitor is rotated through its range. Measurements of this type are made possible because of the isolating resistor in the d-c probe.

Measuring A-V-C Voltage—The automatic-volume-control voltage developed by an incoming signal can be measured at several places in a radio receiver: across the diode load resistor, at points along the a-v-c bus, and at the grids of the r-f or i-f tubes being controlled. *The d-c voltage appearing across the diode load resistor is a very convenient output indication for receiver alignment.*

Measuring Bias-Cell Voltage—Bias-cell voltage can be measured accurately with this instrument. Its high input impedance prevents excessive current drain and consequent damage to cells.

Adjustment of Discriminator Circuits—The voltage developed across the discriminator circuits of f-m receivers or a-f-c circuits can be measured directly at the discriminator, or, in a-f-c circuits, at the grid of the oscillator-control tube.

The zero-center-scale feature of the Master VoltOhmyst is useful in the adjustment of discriminator circuits for zero voltage output. When the discriminator transformer is tuned, the meter pointer swings right or left from the zero-center mark, thus indicating the polarity and the relative amplitude of the d-c voltage developed. As the correct adjustment is approached, the sensitivity of the meter can be increased by setting the VOLTS switch on a lower range, so that the final adjustment will be very accurate.

D-C Supply Voltages—The d-c power-supply voltage can be measured at the rectifier cathode and in the filter circuit; plate voltages at the plates of the various tubes; screen voltages at the screen grids; cathode voltages at the cathodes.

A-C Voltages—The a-c voltmeter is extremely useful in measuring all a-c voltages encountered in the average radio receiver. These voltages include the power-transformer voltages and the audio-frequency voltages developed anywhere from the second-detector load resistor to the speaker voice coil.

The Master VoltOhmyst can therefore be used as an audio-amplifier signal-tracing indicator; it can also be used to measure stage gain or overall gain in an audio amplifier.

Television Receiver Adjustments—This instrument can be used to measure the voltage developed across the picture-channel second-detector load resistor. This measurement is useful in the selection of the optimum orientation and position for the television antenna as well as in the adjustment of antenna matching sections.

Gassy Tubes—The effect of gas in a tube is to cause a voltage, positive with respect to ground, to appear across the tube grid-leak resistor. The effect is to reduce the normal operating bias of the tube, and in some cases even to make the net bias positive, with resultant distortion. In the case of a gassy audio-amplifier tube which is connected directly to the contact arm of the volume control, the grid current due to gas may in time cause the volume control to become noisy. This may happen even though the amount of gas is insufficient to produce a noticeable change in the receiver operation. Consequently, if repeated difficulty is experienced with noisy volume controls in this type of circuit, the Master VoltOhmyst should be used to check for a positive voltage across the grid leak (in this case, between the volume control arm and the low or grounded tap). A positive voltage here may also be caused by a leaky plate-to-grid coupling capacitor; however, if the tube suspected of being gassy is removed and the grid-leak voltage falls to zero, then the tube is definitely gassy.

Pulse Measurements—The peak-to-peak value of voltage pulses can be measured with an accuracy of approximately 2% for pulse-width repetition-rate relations shown graphically in Figure 6. The peak-to-peak value is 2.83 times the reading obtained on the voltage scale (see Figures 2 and 3). For measuring the peak-to-peak values of narrow pulses, the RCA Diode Probe must of course be used as an accessory to the Master VoltOhmyst.

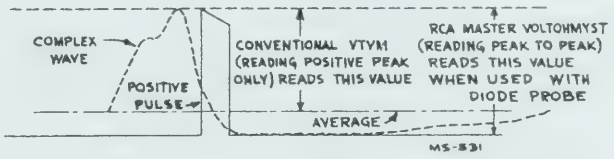
COMPLEX WAVE
POSITIVE PULSE
CONVENTIONAL VTVM (READING POSITIVE PEAK ONLY) READS THIS VALUE
AVERAGE
RCA MASTER VOLTOHMYST (READING PEAK TO PEAK) READS THIS VALUE WHEN USED WITH DIODE PROBE
MS-531

Figure 2

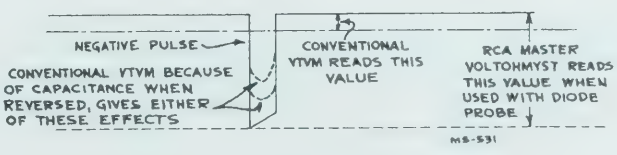
NEGATIVE PULSE
CONVENTIONAL VTVM BECAUSE OF CAPACITANCE WHEN REVERSED, GIVES EITHER OF THESE EFFECTS
CONVENTIONAL VTVM READS THIS VALUE
RCA MASTER VOLTOHMYST READS THIS VALUE WHEN USED WITH DIODE PROBE
MS-531

Figure 3

MAINTENANCE

Although extraordinary care has been taken in the manufacture and design of the RCA Master VoltOhmyst, and despite the fact that each instrument is laboratory tested under strict engineering supervision, it is possible that the instrument may in time require checking and servicing.

To facilitate service, the tube locations, calibration controls, and parts layout are shown in Figure 5. A schematic diagram of the instrument is shown in Figure 7.

The peformance of the Master VoltOhmyst, like that of any other precision instrument, is dependent upon the rating and quality of its components. Therefore, if it becomes necessary to replace a part, the REPLACEMENT PARTS list in this book should be consulted for specifications. Only RCA Replacement Parts or other parts having identical characteristics should be used.

Meter-Pointer Zero Adjustment—The meter pointer should be aligned with the zero marks on the meter scales when the power is off. If it is not, the following check should be made:

Vigorously wipe the meter case window with a clean, soft, dry cloth. If the pointer moves away from zero and remains in a deflected position for several minutes, then the anti-static coating on the inside of the window is ineffective. In this case, the only remedy is to renew the coating. Additional details about this coating material may be obtained by writing to the Test and Measuring Equipment Section, RCA, Camden, New Jersey.

If the meter pointer did not respond to the static test, the following procedure should be used to adjust the mechanical position of the pointer:

1. Unscrew the meter adjustment plug.

2. Insert a scriber or similar tool to engage the meter-pointer adjusting pawls. Move the pawls sideways until the pointer reads exactly zero.

3. Replace the meter adjustment plug.

CAUTION—Extreme care must be taken to prevent insertion of the tool to a depth where it will injure the pointer spring. The guarantee does not cover damage resulting from this adjustment.

Tube Replacement —All tubes are located on the chassis and are accessible for replacement after the rear panel is removed from the case. To remove the rear panel, unscrew the four screws on the rear of the case. To remove the instrument from the case, unscrew the four screws in the corners of the front panel, and the two screws underneath the case, then withdraw the panel-and-chassis assembly.

If it becomes necessary to replace tubes, care should be taken to see that the two RCA-6AK6 tubes are approximately balanced. If they are unbalanced, it will be impossible, when the POLARITY switch is on "+," to bring the pointer to the zeros at the left end of the scale and in the center by means of the ZERO ADJ control. If this should happen, the tubes should be interchanged and the adjustment tried again. If it is still impossible to bring the pointer to zero at both the center and left-hand edge of the meter scale, the tubes have different characteristics and each one should be tried with another tube in order to obtain a matched pair. When the tubes are matched, it will be possible to bring the pointer to zero both at the center of the scale and at the left-hand end of the scale with the ZERO ADJ control. This can be done only when the POLARITY switch is on "+." When this switch is on "–," then it should be impossible to set the pointer to the center-scale zero.

NOTE—Before replacing an RCA-6AK6, age the replacement tube by applying 6.3 volts to its filament for 12 hours.

The circuit design of the Master VoltOhmyst is such that grid current is reduced to a negligible value. However, when replacing tubes, it is advisable to check for grid current as occasionally a gassy tube will be found. The presence of gas is indicated by an appreciable change in the pointer position when the VOLTS switch is changed from "5" to "50" while the SELECTOR switch is in the "DC" position and while no voltage is being measured.

Battery Replacement—Do not allow exhausted batteries to remain in the Master VoltOhmyst. Chemicals leaking from the deteriorated batteries may damage the interior of the instrument. Steel-clad batteries such as the RCA VS-006 are recommended because of their long life and small chance of chemical leakage.

Battery replacement is generally necessary when the ohmmeter readings become unstable, especially on the "RX1" position of the RES/CAP switch. To insure accuracy of the ohmmeter readings, it is suggested that the batteries be checked occasionally as follows:

1. Set the SELECTOR switch to "RES."

2. Set the RES/CAP switch to "RX1," and adjust the RES/CAP ADJ control until the pointer reads full scale.

3. Short circuit the RES/MA and COMMON terminals for about ten seconds.

4. Open the short circuit and immediately observe the meter deflection. A substantial deviation from a full-scale reading indicates that the batteries are weak and should be replaced.

To replace the batteries, remove the rear panel as described under "Tube Replacement," and replace the batteries with two RCA VS-006 1.5-volt cells or the equivalent. The proper position for the cells is shown in Figure 5. Be sure all contacts are clean and tight so that contact resistance will be kept to a minimum.

Calibration—Before adjustments of the calibration controls are made, see that the pointer is mechanically set on zero, and allow the instrument to warm up for 30 minutes. All of the calibration adjustments are located on the rear and left-side aprons of the chassis, and are clearly marked. All calibration adjustments are cemented in place at the factory; the cement can be softened with acetone thinner.

The following procedures are recommended for calibrating the Master VoltOhmyst:

DC + CAL:

1. Set the VOLTS switch on "5," and the POLARITY switch on "+."

2. Set the SELECTOR switch on "DC," and rotate the ZERO ADJ control until the pointer reads zero.

3. Insert the black lead into the COMMON terminal, and the blue probe lead into the VOLTS DC terminal.

4. Connect a standard d-c voltage of four volts between the two test leads. This voltage should be metered with a high-quality, accurate, d-c voltmeter in parallel with the Master VoltOhmyst.

5. Adjust the DC + CAL control until the pointer reads exactly 4 on the scale.

6. Check the accuracy of the instrument on all settings of the VOLTS switch by employing standard voltages of different value on each range. If the accuracy of the meter is not better than ±3% of the full-scale indication on all ranges, then check the multiplier resistors (R17 to 28 incl., R39, 40 and the 1 meg. resistor in the probe) with a reliable bridge.

DC – CAL:

Follow the same procedure given under DC + CAL with the POLARITY switch set on "–," and with the polarity of the standard voltage source reversed. If the various settings of the VOLTS switch checked correctly under the previous DC + CAL test, it will not be necessary to repeat step 6.

AC ZERO; AC CAL:

1. Set the POLARITY switch on "+" or "–," the VOLTS switch on "1," and the SELECTOR switch on "DC."

2. Zero the meter pointer with the ZERO ADJ control.

3. Set the SELECTOR switch on "AC."

4. Plug the a-c probe into the VOLTS AC socket and short-circuit this probe to the COMMON lead.

5. Set the AC ZERO control so that the pointer is aligned with the small red zero on the a-c volts scale.

6. Connect a 60-cycle sine wave of exactly 0.3 volt rms between the a-c probe and the COMMON lead. Adjust the AC CAL control until the meter reads exactly 0.8 volt on the center scale.

7. Check all settings of the VOLTS switch by applying appropriate voltages to the instrument for each setting. If the accuracy is not better than ±3% of the full-scale indication on all ranges, then check the multiplier resistors (R19 to 23 incl., R48 to 51 incl.) with a reliable bridge.

RF ZERO; RF CAL:

1. Set the POLARITY switch on "+" or "–," the VOLTS switch on "5," and the SELECTOR switch on "DC."

2. Zero the meter pointer with the ZERO ADJ control.

3. Set the SELECTOR switch on "RF."

4. Plug the RCA Diode Probe Cable into the VOLTS AC socket and short circuit the probe center-pin to the grounding ring.

5. Set the RF ZERO control so that the meter pointer reads zero. Allow the reading to stabilize, as response to this adjustment is slow.

6. Set the VOLTS switch on "50."

7. Apply a 60-cycle sine wave of exactly 40 volts rms to the probe.

8. Adjust the RF CAL control until the pointer reads exactly 40.

9. Check all settings of the VOLTS switch by applying appropriate voltages to the probe for each setting. Since the multipliers used with the diode probe are the same as those used for d-c voltage measurements, any fault in these multipliers should have been discovered during the DC + CAL test previously described.

CX10 ADJ MAX; CX10 ADJ C.S.; CX100 ADJ MAX:

1. Set the SELECTOR switch on CAP and adjust the ZERO ADJ control for zero pointer reading (small red zero on capacity scale).

2. Set the RES/CAP switch on "CX0.1."

3. Short-circuit the CAP and COMMON terminals, then rotate the RES/CAP ADJ control until the pointer is aligned with the last line on the right-hand side of the top scale.

4. Set the RES/CAP switch to "CX.01," then to "CX.001." The meter should still read full scale.

5. Set the RES/CAP switch to "CX1.0 mf." The meter reading should be within –1.5 divisions of full scale on the center scale.

6. Set the RES/CAP switch to "CX10 mmf," then set the CX10 ADJ MAX trimmer until the meter reads exactly full scale.

7. Remove the short circuit from the CAP and COMMON jacks, and in its place connect a 100-mmf standard capacitor.

8. Set the CX10 ADJ C.S. trimmer for a meter reading of exactly ten on the capacity scale. If this adjustment cannot be made, the capacity-measuring winding on the power transformer probably has excess distributed capacity.

9. Remove the capacitor. The meter should indicate less than two mmf. (less than 0.2 on the capacity scale). If the reading is greater than this, the power transformer probably has a defective shield.

10. Set the RES/CAP switch to "CX100 mmf." and short-circuit the CAP and COMMON terminals.

11. Set the CX100 ADJ MAX trimmer for a full-scale meter reading.

12. Remove the short circuit and in its place connect a 1000-mmf standard capacitor. The meter reading should not differ from the capacitor value by more than ±10%.

13. Remove the capacitor. The meter should read less than one scale division.

Replacing Diode in Diode Probe—Failure of the RCA 6AL5 diode in the Diode Probe will normally cause the meter to deflect sharply to the left when the SELECTOR switch is on "RF." An open filament can usually be detected by feeling the probe since the diode heater warms the probe body slightly. RF calibration should be checked whenever the diode is replaced.

To gain access to the RCA-6AL5 in the probe for examination or replacement refer to Figure 4 and proceed as follows:

CAUTION—Do not attempt to unscrew the knurled ring on the probe front until step 6 of the following procedure has been completed.

1. Unscrew the streamlined cap from the rear of the probe and push cap, washer, and bakelite cover back over the cable.

2. Unscrew the hex nut at the rear of the probe, being careful not to turn the bushing with respect to the metal probe body.

3. Push the bushing into the probe body far enough to disengage the locking pin.

4. Unscrew the rear half of the probe body from the front half, and push the rear half back over the cable. The 6AL5 will then be exposed, making examination or replacement possible.

5. If it is necessary to remove the diode socket and capacitor assembly, unscrew the threaded bushing which holds the two halves of the probe together. This operation is facilitated by inserting a nail or some similar instrument through the holes in the bushing.

6. Heat the probe tip with a soldering iron until the solder is melted, then withdraw the diode socket and capacitor assembly from the rear of the front half of the probe body.

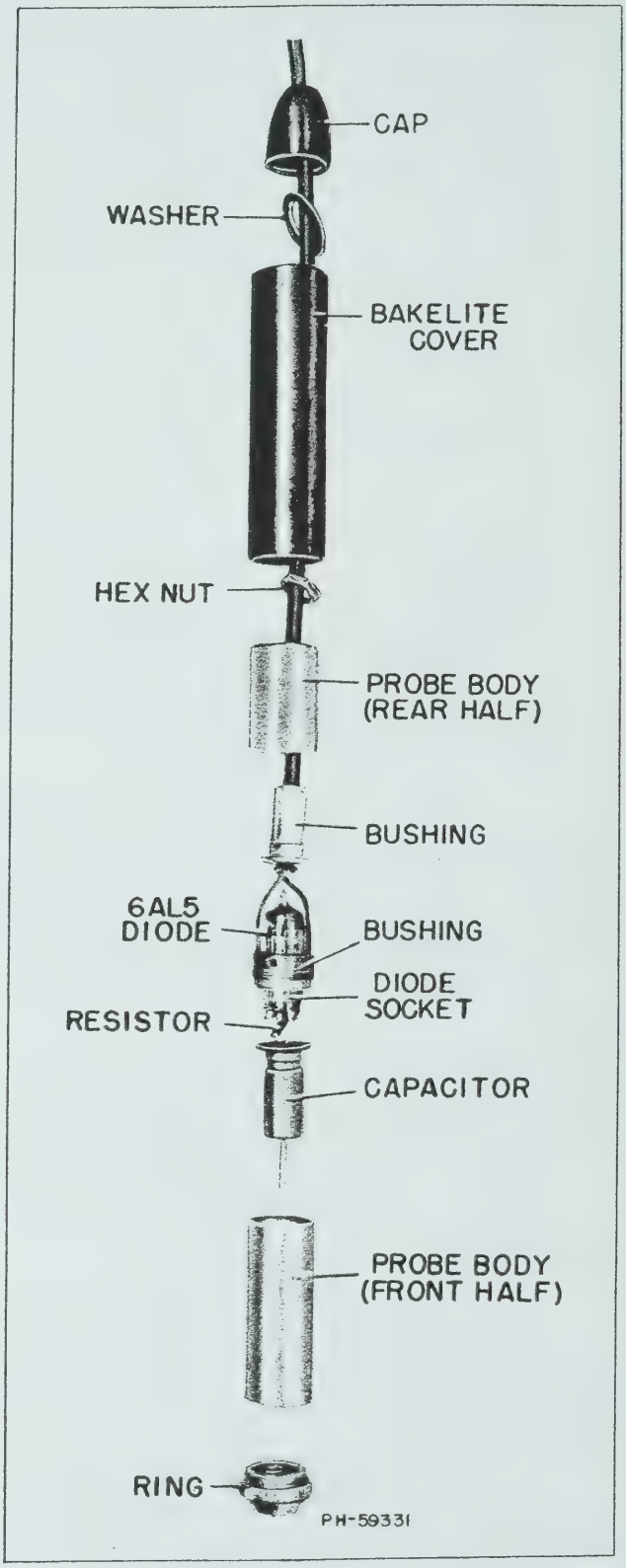

Figure 4—Exploded View of RCA Diode Probe

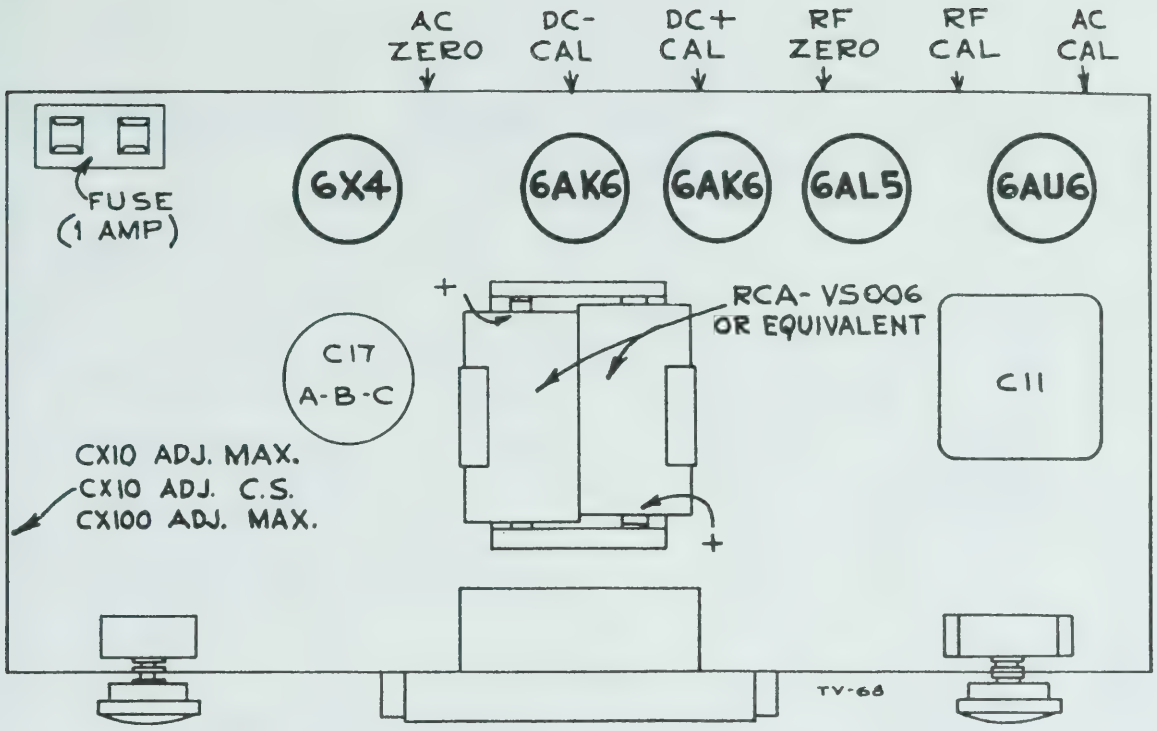

Figure 5—Tube and Adjustment Layout

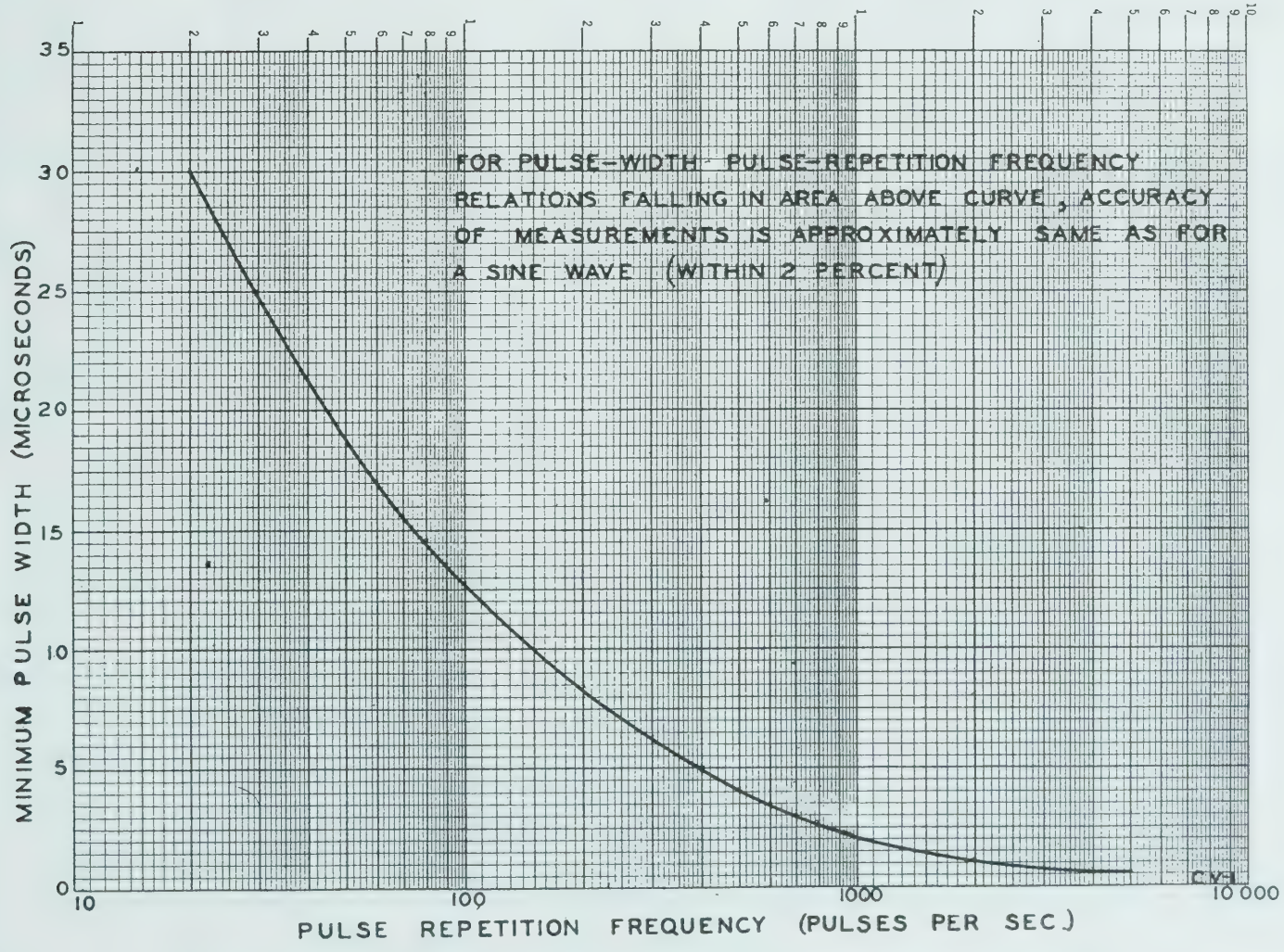

Figure 6—Pulse-Width Repetition-Rate Relation Curve for Use with RCA Diode Probe

SYMBOL	SWITCH FUNCTION	POSITION 1	POSITION 2	POSITION 3	POSITION 4	POSITION 5	POSITION 6	POSITION 7
S1	SELECTOR	CURRENT	D.C. VOLTS	R.F. VOLTS	A.C. VOLTS	CAPACITY	RESISTANCE	
S2	RES/CAP RANGE	R X 1 C X 10 MMFD	R X 10 C X 100 MMFD	R X 100 C X .001 MFD	R X 1000 C X .01 MFD	R X 10,000 C X 0.1 MFD	R X 1 MEG C X 1 MFD	
S3	VOLTS RANGE	1 VOLT (A.C. ONLY)	5 VOLTS	10 VOLTS	50 VOLTS	100 VOLTS	500 VOLTS	1000 VOLTS
S4	CURRENT RANGE	10 U.A.	100 U.A.	1 M.A.	10 M.A.	100 M.A.	1-10 AMPS	
S5	POWER & POLARITY	(POWER) OFF	(D.C.) +	(D.C.) −				

ALL RESISTANCE VALUES IN OHMS.
ALL CAPACITANCE VALUES BELOW ONE IN MF. AND ABOVE ONE IN MMF UNLESS OTHERWISE NOTED.

ARROWS AT CONTROLS INDICATE CLOCKWISE ROTATION

ALL SWITCH SECTIONS VIEWED FROM FRONT OR KNOB END OF SWITCH

ROTORS SHOWN IN EXTREME COUNTER CLOCKWISE (LEFT) POSITION

SWITCH LEGEND

DUMMY LUGS
LONG LUG
SHORT LUG
INSULATED LUG
THROUGH ELECTRICAL CONNECTION
THROUGH ELECTRICAL CONNECTION

AUDIO AMPLIFIER
DIODE
COLLECTOR
D.C. AMPLIFIER
D.C. AMPLIFIER
ZERO ADJUST
SELECTOR
CURRENT RANGE
SELECTOR
POLARITY
VOLTS RANGE
RES/CAP RANGE
VOLTS RANGE
RES/CAP RANGE
SELECTOR
SELECTOR
SELECTOR
CAP
RECTIFIER
A.C. ZERO
R.F. ZERO
J1 VOLTS D.C.
J2 RES/CUR
J3 VOLTS A.C.
J4 COMMON
J5 CASE
J6 10 AMP
J7 1 AMP
J8
J9 LINE
117 VOLTS 60 ~

Figure 7—Schematic Circuit Diagram

REPLACEMENT PARTS LIST

TYPE WV-95A MASTER VOLTOHMYST

SYMBOL NO.	DESCRIPTION	STOCK NO.
C-1	Capacitor—Paper Tubular, .01 mfd., 20% 400 Volts	70610
C-2	Capacitor—Paper Tubular, .1 mfd., 20%, 200 Volts	70617
C-3	Capacitor—Paper Tubular, .25 mfd., 20%, 400 Volts	70618
C-4	Capacitor—Fixed Mica, 3300 mmfd., 20%, 500 Volts	39664
C-5, 6	Same as C-2	
C-7	Same as C-4	
C-8	Capacitor—Paper Tubular, .1 mfd., 20%, 600 Volts	70639
C-9	Capacitor—Paper Tubular, .05 mfd., 20%, 400 Volts	70615
C-10	Capacitor—Paper Tubular, .05 mfd., 20%, 1000 Volts	70657
C-11	Capacitor—Paper, Steel Case, 9.0 mfd., 5%, 100 V. D. C.	55847
C-12	Capacitor—Paper Tubular, 0.9 mfd., 5%, 100 Volts	55848
C-13	Capacitor—Paper Tubular, .09 mfd., 5%, 100 Volts	55875
C-15	Capacitor—Fixed Mica, 820 mmfd., 5%, 500 Volts	39650
C-14A, B, C	Capacitor—Variable Trimmer, 40-370 mmfd., 4-70 mmfd., 3-35 mmfd.	56179
C-16	Capacitor — Fixed Mica, 10,000 mmfd., 5%, 300 Volts	92036
C-17A, B, C	Capacitor—Dry Electrolytic, 20-20-20 mfd., 150 Volts	37637
F-1	Fuse—Glass Tubular, 1 Ampere	14133
I-1A	Lamp—Pilot Lamp	11891
I-1B	Socket—Pilot Light Socket Assembly	54495
J-1	Connector—Chassis, with Terminal and Int. Tooth, Volts DC	68439
J-2, 6, 7, 8	Jacla—Pin, RES/MA., CAP., 10 AMP., 1 AMP. (Red)	55238
J-3	Connector—Chassis, 4 Contact (Female) Volts AC	52823
J-4, 5	Jack—Pin, Common, Case (Blue)	55239
J-9	Plug—Chassis, Line Voltage, 2 Contacts (Male)	71448
M-1	Meter—200 Microamps. Complete with Case and Scale	55845
R-1	Resistor — Fixed Composition, 10 Megohms, 20%, ½ Watt	
R-2	Resistor — Fixed Composition, 1.0 Megohm, 20%, ½ Watt	
R-3	Resistor—Fixed Composition, 22,000 Ohms, 5%, ½ Watt	
R-4	Resistor—Fixed Composition, 2800 Ohms, 1%, ½ Watt	55850
R-5	Resistor — Fixed Composition, 1 Megohm, 5%, ½ Watt	
R-6	Resistor—Fixed Composition, 22,000 Ohms, 1%, ½ Watt	55851
R-7	Resistor — Variable, Wire Wound, RF Zero, 20 Oms, 2 Watt	52822
R-8, 9	Resistor — Fixed Composition, 470,000 Ohms, 5%, ½ Watt	
R-10	Resistor — Fixed Composition, 3.3 Megohms, 20%, ½ Watt	
R-11	Resistor—Fixed Composition, 3600 Ohms, 1%, ½ Watt	55852
R-12	Resistor—Fixed Composition, 47,000 Ohms, 1%, ½ Watt	55853
R-13	Resistor—Fixed Composition, 20,000 Ohms, 5%, ½ Watt	
R-14	Resistor — Variable, Composition, RES/CAP ADJ, 15,000 Ohms, Linear Curve	55844
R-15	Resistor—Fixed Composition, 13,000 Ohms, 5%, ½ Watt	
R-16	Same as R-11	
R-17	Resistor—Fixed Composition, 40,000 Ohms, 1%, ½ Watt	55854
R-18	Resistor—Fixed Composition, 5,000 Ohms, 1%, ½ Watt	55855
R-19	Resistor—Fixed Composition, 4,000 Ohms, 1%, ½ Watt	55856
R-20	Resistor — Fixed Composition, 500 Ohms, 1%, ½ Watt	55857
R-21	Resistor — Fixed Composition, 400 Ohms, 1%, ½ Watt	55858
R-22	Resistor — Fixed Composition, 90 Ohms, 1%, ½ Watt	55859
R-23	Resistor — Fixed Composition, 9.5 Ohms, 1%, ½ Watt	55860

REPLACEMENT PARTS LIST (CONTINUED)

SYMBOL NO.	DESCRIPTION	STOCK NO.
R-24	Resistor—Fixed Composition, 50,000 Ohms, 1%, ½ Watt	55861
R-25	Resistor—Fixed Composition, 400,000 Ohms, 1%, ½ Watt	55862
R-26	Resistor—Fixed Composition, 500,000 Ohms, 1%, ½ Watt	52819
R-27	Resistor — Fixed Composition, 4.0 Megohms, 1%, 1 Watt	55863
R-28	Resistor — Fixed Composition, 5.0 Megohms, 1%, 1 Watt	55864
R-29	Resistor—Fixed Composition, 225,000 Ohms, 1%, ½ Watt	55865
R-30	Resistor—Fixed Composition, 22,500 Ohms, 1% ½ Watt	55866
R-31	Resistor—Fixed Composition, 2250 Ohms, 1%, ½ Watt	55867
R-32	Resistor — Fixed Composition, 225 Ohms, 1%, ½ Watt	55868
R-33	Resistor — Fixed Composition, 25 Ohms, 1%, ½ Watt	55869
R-34, 35, 36 37	Resistor — Variable, Wire Wound, 8000 Ohms	43916
R-38	Same as R-14	
R-39	Resistor — Fixed Composition, 4.5 Megohms, 1%, 1 Watt	55870
R-40	Resistor—Fixed Composition, 1.2 Megohms, 1%, 1 Watt	55871
R-42, 43	Resistor — Fixed Composition, 36 Megohms, 1%, 1 Watt	55872
R-44	Resistor—Wire Wound, 2.4 Ohms, 10%	51953
R-48	Resistor—Fixed Composition, 400,000 Ohms, 1%, 2 Watt	55873
R-49	Same as R-24	
R-50	Same as R-17	
R-51	Same as R-18	
R-52	Resistor—Fixed Composition, 100,000 Ohms, 20%, ½ Watt	
R-53	Same as R-13	
R-54	Resistor — Fixed Composition, 330 Ohms, 5%, ½ Watt	
R-55	Resistor — Variable, Composition, AC ZERO, 1000 Ohms	53863
R-56	Same as R-54	
R-57	Resistor—Fixed Composition, 15,000 Ohms, 5%, ½ Watt	
R-58	Resistor—Fixed Composition, 5600 Ohms, 10%, ½ Watt	
R-59	Resistor—Adjustable Wire Wound, Overall Resistance—700 Ohms, 10%, 2 Watt	55874
S-1A, B, C D, E, F	Switch — Selector, Rotary Wafer Type, 3 Sections, 8 Circuit, 6 Positions	55840
S-2A, C, D	Switch — RES/CAP Range, Rotary Wafer Type, 2 Sections, 3 Circuits	55842
S-3A, S-3D	Switch — VOLTS Range, Rotary Wafer Type, 2 Sections, 2 Circuit, 7 Positions	55841
S-4A, B, L	Switch—CURRENT Range, Rotary Wafer Type, 2 Sections, 6 Positions	55839
S-5A, B	Switch — POLARITY, Rotary Wafer Type, 1 Section, 5 Circuit, 3 Positions	55843
T-1	Transformer—Power, Pri.-117 Volt, 50/60 Cycle	56127
	Sec. No. 1—5.7 V., 1.63 Amp.	
	Sec. No. 2—94 V. (DC) 60 Ma.	
	Sec. No. 3—Tapped for 1.0 V., 4 Ma., 10.64 V. and 250 Volt	
X-1, 2, 3, 4, 5	Socket—Tube, Miniature, 7 Contacts	73115
	Board—Fuse Mounting	55316
	Case—Meter	55846
	Handle—Carrying Handle	53704
	Knob—Large, for ZERO ADJ, POLARITY, RES/CAP, VOLTS, SELECTOR, CURRENT	53683
	Knob—Small, RES CAP ADJ Control (Blue)	53689
	Plate—Capacitor Mounting	28452
	Pointer—For Large Control Knob.	53684

MASTER VOLTOHMYST

TYPE WV-95A

PH256

TEST AND MEASURING EQUIPMENT SECTION

RADIO CORPORATION OF AMERICA

CAMDEN, NEW JERSEY, U.S.A.

IB-4095-1

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IMPORTANT

THIS INSTRUMENT IS SHIPPED WITHOUT BATTERIES. REFER TO THE INSTRUCTIONS ON PAGE 10 FOR THEIR INSERTION.

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MASTER VOLTOHMYST

TYPE WV-95A

TECHNICAL SUMMARY

Electrical Characteristics

D-C VOLTMETER

Ranges .....0 to 5-10-50-100-500-1000 volts.
Input resistance ....11 megohms for all ranges —includes 1 megohm in probe.
Sensitivity (max.) ..2.2 megohms per volt on 5-volt range.
Circuit .....Differential degenerative vacuum-tube bridge.

D-C AMMETER

Ranges .....0 to 10-100 microamperes, 0 to 1-10-100 milliamperes using d-c amplifier; 0 to 1-10 amperes direct to meter.

OHMMETER

Ranges .....0.1 ohm to 1000 megohms in 6 ranges.

A-C VOLTMETER (AUDIO FREQUENCY)

Ranges .....0 to 1-5-10-50-100-500-1000 volts rms.
Input impedance (with cable) .....Approx. 5 megohms resistance shunted with approx. 125 mmfd. capacity.
Frequency response..Flat from 30 to 20,000 cycles.
Circuit .....A-f feedback amplifier and balanced linear diode with d-c bridge amplifier.

CAPACITY METER

Ranges .....4 mmfd. to 1000 mfd. in 6 ranges.
Polarizing voltage ..50 volts d.c. available on high-capacity range.

MULTIPLIERS

Accuracy .....±1% matched pair, aged resistors.

INDICATING METER

Sensitivity .....200 microamperes (full-scale).
Accuracy .....±2% of full-scale indication.

TUBE COMPLEMENT

2 RCA 6AK6 .....Vacuum-tube bridge.
1 RCA 6AL5 .....Diode.
1 RCA 6AU6 .....Audio amplifier.
1 RCA 6X4 .....Rectifier.

POWER SUPPLY

Voltage rating .....105-125 volts, 50-60 cycles (specifications are based on 117 volts, 60 cycles).
Power consumption..15 watts.
Battery for ohmmeter circuit .....Two 1.5-volt flashlight cells (RCA VS006 or equivalent).

ACCESSORIES (Available but not supplied as part of the WV-95A)

RCA Diode Probe (MI-8275) .....For r-f measurements up to 100 volts rms and at frequencies to 250 mc.

RCA Crystal Probe (MI-8263) .....For r-f measurements at frequencies up to 250 mc and at potentials not exceeding 20 volts positive peak in which a very low input capacity is required.

Mechanical Characteristics

Overall Dimensions..Height, 9⅞"; width; 13¾"; depth, 7½".
Weight .....15 lbs.
Finish .....Blue-grey hammeroid case with anodized satin aluminum panels.

GENERAL DESCRIPTION

The Master VoltOhmyst, Type WV-95A, is an electronic meter designed to measure resistance, capacitance, direct current, d-c voltage, and a-c voltage (audio frequency and radio frequency) over extremely wide ranges. Outstanding features of the instrument are: ease of operation; isolated measuring circuit for reading up to 1000 volts d-c or 230 volts rms (a-c) above ground; high input resistance; automatic protection of the indicating meter against burnout; simplicity of meter scales; "Zero Adjust" that does not have to be reset when ranges are changed; a zero-center scale for use in

aligning f-m and a-f-c discriminator circuits; and provision for the use of the RCA Diode Probe or the RCA Crystal Probe to measure r-f voltages up to 250 megacycles.

The principal part of this instrument consists of two RCA 6AK6 miniature tubes in a push-pull d-c vacuum-tube voltmeter circuit which is characterized by excellent linearity and stability. Both tubes are coupled to a common, high-value bias resistor. The control grid of one of the tubes is permanently grounded, and the voltage to be measured is applied to the grid of the other tube. This voltage is always a d-c voltage; moreover, it is proportional to the magnitude of the quantity being measured. For instance, variations in the values of resistances or capacitances being measured are converted to corresponding variations in the value of the d-c voltage applied to the vacuum-tube bridge. Because of the common cathode coupling, any change in the voltage applied to the grid of one tube produces a change in the cathode bias of the other. As a result, the change in plate current of one tube is accompanied by a simultaneous opposite change in the plate current of the other. The differential voltage developed across the plate load resistors by the plate current is applied, through a polarity-reversing switch, to the meter, which is calibrated in direct current, d-c volts, a-c volts, resistance, and capacity.

Audio-frequency voltage to be measured is passed through a range attenuator to an RCA-6AU6 audio amplifier. The use of feedback in this circuit results in a linear amplifier with good stability and high input impedance. The amplified a-c voltage is applied to an RCA-6AL5 diode rectifier, which furnishes the vacuum-tube bridge with a d-c voltage proportional to the positive-peak value of the measured a-c voltage. The meter scale is calibrated in r-m-s values of a sine wave.

Direct current, on all but the 1- and 10- amp ranges, is measured by passing the current through suitable shunts, and utilizing the resulting voltage drop to drive the vacuum-tube bridge. On the 1- and 10-amp ranges, the current is passed directly through the indicating meter and a low-impedance meter shunt. This is done to keep the instrument from introducing an excessive voltage drop into low-voltage circuits where high-current measurement might be required.

Radio-frequency voltages can be measured when the RCA Diode Probe is used with the Master VoltOhmyst. This probe, which is stocked as MI-8275, is available on separate order. Also available for this purpose is the RCA Crystal Probe, MI-8263.

A special circuit is used to measure capacity over wide ranges with a single meter scale. The unknown capacity is connected in series with a capacity standard and a 0.01- mfd. capacitor. Across the series combination is applied a 60-cycle voltage of proper magnitude. This 60-cycle voltage is distributed across the capacitors in the series circuit in proportion to their reactances at this frequency. The drop across the 0.01-mfd capacitor is measured by means of the audio amplifier and diode circuits, and the resulting meter deflection is read on a meter scale calibrated directly in mfd, or mmfd., according to the range in use. Polarizing voltage from the d-c power supply is applied through a 100,000-ohm resistor to the capacity test jacks on the highest-capacity range. By means of this polarizing voltage, electrolytic capacitors may be measured with d-c voltage applied.

An RCA-6X4 miniature rectifier is employed to supply the d-c voltages required by the Master VoltOhmyst. The power transformer is of special design, having in addition to plate and filament windings, a special winding which supplies the a-c voltages required by the capacity-measuring circuit. This special winding is shielded by three electrostatic shields, two of which are ungrounded.

The low side of the measuring circuit is isolated from the chassis, and a separate case ground terminal is provided. This allows measurements to be made in circuits where both meter leads will be above ground potential. Under this condition the Master VoltOhmyst case alone can be grounded for safety reasons.

HOW TO USE THE RCA MASTER VOLTOHMYST

SAFETY PRECAUTIONS

HIGH VOLTAGES ARE DANGEROUS! For your personal safety, the following precautions should be observed while you are working around high-voltage equipment:

a. Avoid working alone when possible. Serious consequences of electrical shock can be avoided by the presence of a second person to remove power and apply resuscitation when necessary.

b. Avoid contact with or even close proximity to high-voltage points. If you are not familiar with the equipment, find out where high-voltage points exist before proceeding with measurements.

c. If possible, when making high-voltage measurements, remove the voltage from the circuit under test while attaching the meter leads.

d. If it is impracticable to turn the power off during measurements, the following precautions are recommended:

1. Connect the CASE terminal of the instrument to a good ground.
2. Make sure that the clip on the lead from the COMMON terminal is securely attached to the low side of the voltage to be measured. Use of the RCA Binding Post Pin Plugs will prevent the test leads from becoming detached from the Volt-Ohmyst case.
3. Keep your fingers well away from the probe tip.
4. Avoid contact between any part of your body and ground. If the floor is not insulated, find some dry insulating material to stand on. Do not lean against or rest your free hand on an equipment rack, a metal bulkhead or anything else providing a ground return.

e. Do not use leads with defective insulation.

f. Never leave the meter connected to a high-voltage point after measurements have been completed.

g. Do not depend on immediate removal of voltage from high-voltage circuits when the main power switch is opened. Sometimes filter capacitors will retain sufficient charge to cause serious injury. In cases where high voltage is supplied by a motor-generator set, the main switch may turn off only the motor power, so that voltage will be present until the machine stops.

h. DO NOT CONNECT THE CASE TERMINAL OF THE MASTER VOLTOHMYST TO A HIGH-VOLTAGE POINT!!! Failure to observe this precaution may result in a severe shock, since the CASE terminal connects directly to the metal case of the instrument.

PRELIMINARY ADJUSTMENT

Connect as required, the blue lead to the terminal marked VOLTS DC, one of the black leads to the COMMON terminal, the red lead to the RES/MA terminal, and the red probe lead to the VOLTS AC terminal. Before turning the instrument on, check the zero setting of the meter pointer. If the pointer is not on zero, refer to the instructions under "Maintenance" for setting the meter pointer.

Plug the power cord into a 117-volt, a-c supply, and adjust the controls as follows:

POLARITY—Set to "+" or "−" (this switch applies power to the instrument)

SELECTOR—Turn to "DC".

ZERO ADJ—Set so that the meter pointer reads zero on all scales.

SELECTOR—Turn to "RES" (the pointer should deflect to approximately full scale)

RES/CAP ADJ—Set so that the meter pointer reads exactly to the last line on the "R" scale.

The instrument is now ready for use in the measurement of resistance, direct current, d-c voltage, and audio- and radio-frequency voltage.

NOTE—When accurate readings are required, the instrument should be allowed to warm up for at least ten minutes before the adjustments described above are made.

OPERATION

-C Voltage Measurements—The d-c voltmeter nas six ranges: 0 to 5, 10, 50, 100, 500, and 1000 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two center d-c voltage scales. The d-c voltmeter will not read when the VOLTS switch is set on "1"; therefore, this position of the switch is never used when d-c voltages are being measured. For d-c voltage measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "−".

SELECTOR—Set on "DC".

VOLTS—Select a range including the value of the voltage to be measured.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured (see Safety Precautions).

DC VOLTS—Connect or touch the d-c probe (blue lead) to the high side of the voltage to be measured.

NOTE—When high voltages are to be measured, connect the CASE terminal of the instrument to a good ground, such as a cold-water pipe.

Zero-Center Application—Provisions have been made to shift the d-c zero reading to the center of the scale when it is desirable to observe the d-c voltage variation around zero volts. Both positive and negative voltage excursions can be observed

without resetting the POLARITY switch each time the polarity of the voltage changes.

To use the zero-center feature of the Master VoltOhmyst, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+ ".

SELECTOR—Set on "DC".

ZERO ADJ—Set so that the meter pointer is directly over the "0" mark at the center of the meter scale.

VOLTS—Set to the desired voltage range.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured.

VOLTS DC—Connect or touch the d-c probe (blue lead) to the high side of the voltage to be measured.

Direct Current Measurements—The direct-current meter has seven ranges: 0 to 10, 100 microamperes; 0 to 1, 10, 100 milliamperes; and 0 to 1, 10 amperes. When the proper range has been selected on the CURRENT switch, the current may be read directly from the direct-current scale.

For direct-current measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "CUR".

CURRENT—Select a range including the value of the current to be measured.

Terminal Connections:

COMMON—Connect the black clip-lead into circuit so that the current to be measured must flow through this lead.

RES/MA—If the current to be measured is less than 100 ma, connect the red lead between this terminal and the other side of the circuit.

1 AMP—If the current to be measured is between 100 ma and 1 amp, connect the red lead to this terminal.

10 AMP—If the current to be measured is between 1 amp and 10 amps, connect the red lead to this terminal.

CAUTION—In the "1-10 AMP" position of the CURRENT switch, the measured current flows directly through the indicating meter, so that the anti-meter-burnout feature of the Master VoltOhmyst is not effective. Reasonable precautions should be taken to prevent meter burnout when the "1-10 AMP" setting of the CURRENT switch is employed.

NOTE—The zero-center feature of the instrument is also available when metering direct current. The procedure is analagous to that described under "Zero Center Applications," except, of course, the SELECTOR switch is set on "CUR," and the CURRENT switch is used to select the proper ranges.

Audio-Frequency Voltage Measurements—The a-c (audio-frequency) voltmeter has seven ranges: 0 to 1, 5, 10, 50, 100, 500, and 1000 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two center scales. If the a-c voltage is a sine wave, then the voltage is read from the meter scale as the r-m-s value. If the voltage is not a sine wave, then the meter reading, when multiplied by 1.414, will give the positive-peak value of the voltage.

For audio-frequency voltage measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "AC".

VOLTS—Select a range including the value of the voltage to be measured. If the ZERO ADJ control has been previously set as described under "Preliminary Adjustments," then, when the VOLTS switch is on "1," the meter pointer will be automatically aligned with the small red zero on the bottom half of the center scale. This zero appears just to the right of the normal zero for that scale, and is the zero which should be used when the VOLTS switch is on "1." If the pointer does not automatically read to this zero, then the AC ZERO control inside the case should be adjusted as described in the Maintenance section of this book. For all other positions of the VOLTS switch, the black zero is used.

Terminal Connections:

COMMON—Connect the black clip-lead to the grounded or low side of the voltage to be measured.

VOLTS AC—Connect or touch the a-c probe (red lead with 4-prong plug) to the high side of the voltage to be measured.

Radio-Frequency Voltage Measurements— For this application, the RCA Diode Probe or Crystal Probe is required. These are not supplied with the Master VoltOhmyst, but are available on separate order. The application of the Diode Probe only will be considered here. Instructions for using the Crystal Probe are furnished with the probe. The r-f voltmeter has four ranges: 0 to 5, 10, 50 and 100 volts. When the proper range has been selected on the VOLTS switch, the voltage may be read directly from one of the two bottom red scales on the two lower ranges (0 to 5, 10),

or from one of the two center black scales on the two upper ranges (0 to 50, 100). If the a-c voltage is a sine wave, then the voltage is read from the meter scale as the r-m-s value. If the voltage is not a sine wave, then the meter reading, when multiplied by 2.83, will give the peak-to-peak value of the voltage.

CAUTION—To avoid damage to the probe, refer to the "ACCESSORIES" section of the Specifications and do not exceed the input voltage indicated.

For r-f voltage measurements with the Diode Probe, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set on "+" or "–".

SELECTOR—Set on "RF". In this position of the switch the pointer will normally deflect to the left, unless the Diode Probe is in its socket.

VOLTS—Select a range including the value of the voltage to be measured. As mentioned before, only the "5", "10", "50", and "100" positions of the VOLTS switch are used in this particular application.

Terminal Connections:

VOLTS AC—For high radio-frequency measurements the center pin of the RCA Diode Probe should be connected directly to the high side of the voltage to be measured, while the knurled ring of the probe should be connected directly to the grounded or low side. The grounding ring is tapped for a $\frac{5}{8}$"-24 N.E.F.2 thread, so that the probe will mate with an Amphenol 83-1R connector, a Navy type CPH 49194 connector, an Army type SO-239 connector or any similar type. In cases where direct connection to one of these connectors is impracticable, satisfactory results can be obtained by using a short extension made of coaxial cable.

For low radio-frequency measurements the clips may be used. The large clip screws on the center pin of the probe; the short black clip-lead screws into the tapped hole in the side of the grounding ring.

Measuring A-C (audio or radio frequency) when D-C is Present—When both alternating and direct voltages are present, the a-c component of the voltage can be measured with the Master VoltOhmyst by following the procedure outlined for audio- and radio-frequency measurements. If the d-c component exceeds 600 volts, a one-microfarad (or larger) capacitor of adequate voltage rating should be used in series with the probe input.

Resistance Measurements—Before attempting to measure resistance, see that no voltage exists across the component to be checked. Resistance is read directly in ohms from the upper black scale of the meter.

For resistance measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set to "+" or "–".

SELECTOR—Set to "RES".

RES/CAP—Select a range including the value of the resistance to be measured. It is recommended that the "RX1" position of the RES/CAP switch be used only for resistances below 20 ohms.

RES/CAP ADJ—Set so that the meter pointer is aligned to the last line on the right-hand side of the resistance scale.

Terminal Connections:

COMMON—Connect the black clip-lead to one side of the resistance to be measured.

RES/MA—Connect the red clip-lead to the other side of the resistance.

To cancel the lead-resistance error when making resistance measurements below two ohms, short the test leads together and reset the ZERO ADJ control so that the pointer reads exactly zero. When the low-resistance checks have been completed, the ZERO ADJ control should be reset so that the meter pointer reads zero when the SELECTOR switch is on "DC."

When measuring high resistances, keep the fingers away from the tip of the ohms probe (red lead) to eliminate a possible leakage or stray-pickup error. This is especially important when the "RX10,000" and "RX1 MEG" positions of the RES/CAP switch are employed.

CAUTION—The Master VoltOhmyst applies up to three volts across the resistance being measured when the RES/CAP switch is set to "RX1" or "RX10." When it is necessary to check the continuity or to measure the resistance of a low-resistance device having a small current-carrying capacity, such as the filament of a low-voltage vacuum tube or a thermocouple, then a resistor should be used in series with the ohmmeter leads, or a range above "RX10" should be used.

A periodic check of the battery voltage should be made to insure accurate ohmmeter readings. Refer to the "Maintenance" section for instructions on replacing batteries.

Measuring Resistance Above 1000 Megohms—The Master VoltOhmyst can be used to measure resistances higher than those covered by the "RX1 MEG" setting of the RES/CAP switch. This application is especially useful for the measurement of capacitor or insulation leakage resistance.

The method requires an external voltage source, ranging in value from 20 to 500 volts, to produce

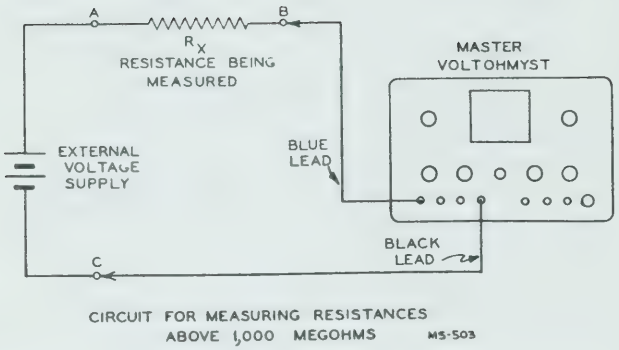


Figure 1

a measureable current through the resistance being checked.

Make the connections portrayed in Figure 1. Set the SELECTOR switch to "DC" and measure the voltage from point "B" to point "C." Then measure the voltage between point "A" and point "C." For accurate measurements, the value of voltage from the external source must be sufficient to produce a readable meter deflection when the meter is connected between "B" and "C." The unknown resistance can be computed from the following formula:

$$\text{Unknown Resistance in megohms} = 11 \times \frac{\text{VOLTS}_{AC} - \text{VOLTS}_{BC}}{\text{VOLTS}_{BC}}$$

Example:

Suppose the voltage between "A" and "C" is 500 volts; the voltage between "B" and "C" is 2 volts.

Then:

$$\text{Unknown resistance} = 11 \times \frac{500 - 2}{2} = 2739 \text{ megohms}$$

Capacity Measurements—The capacity meter has six ranges: CX10 mmf; CX100 mmf; CX.001 mf; CX.01 mf; CX0.1 mf; and CX1.0 mf. When the proper range has been selected on the RES/CAP switch, the capacity can be read directly from the upper red meter scale.

To make capacity measurements, set the controls and connect the terminals as follows:

Controls:

POLARITY—Set to "+" or "–".

SELECTOR—Set to "CAP".

ZERO ADJ—Set so that the meter pointer is aligned with the small red zero on the bottom half of the upper scale. This zero appears just to the right of the zero for the resistance scale.

RES/CAP ADJ—Short circuit the COMMON and CAP terminals, then adjust this control until the meter pointer is aligned with the last mark on the right-hand side of the upper scale.

RES/CAP—Select a range including the value of the capacity to be measured.

Terminal Connections:

CAP—Connect one side of the capacitor to be tested to this terminal.

COMMON—Connect the other side of the capacitor to this terminal.

When the "CX1.0 mf" setting of the RES/CAP switch is employed, a polarizing voltage of 50 volts is applied between the CAP and COMMON terminals. If electrolytic capacitors are to be checked, the positive side of the capacitor should be connected to the CAP terminal, and the negative side to the COMMON terminal.

Since leaky capacitors will give an inaccurate capacity indication, capacitors suspected of leakage should be checked with the ohmmeter section of the instrument to determine whether or not a high-resistance d-c leak exists. Then, if no leak is present, the capacity measurement can be made.

When making measurements on very small capacities (on the order of a few micro-microfarads), the capacitors should be attached to the binding post terminals so that they are positioned as far away from the front panel as possible. Also, all stray matter (test leads, hands, etc.) should be kept away from the capacitor under test while the measurement is being made. It should be remembered that the Master VoltOhmyst measures the actual capacity between the CAP and COMMON terminals, which includes the capacity under test plus any stray capacity. Anything that will minimize the stray capacity will increase the accuracy of the measurement.

SPECIAL APPLICATIONS

The RCA Master VoltOhmyst will be found useful for many applications in the servicing of all types of electronic equipment. Its possible uses in this field are too numerous to be covered in detail in this book. However, several applications which are considered to be of particular interest are described in the following paragraphs:

Measuring Oscillator Strength—The negative d-c voltage developed at the grid of an oscillator is proportional to the strength of oscillation. This voltage can be measured readily with the Master VoltOhmyst. To determine the relative strength of oscillation of a radio-receiver local oscillator at different frequencies, comparative readings should

be taken for each band while the main tuning capacitor is rotated through its range. Measurements of this type are made possible because of the isolating resistor in the d-c probe.

Measuring A-V-C Voltage—The automatic-volume-control voltage developed by an incoming signal can be measured at several places in a radio receiver: across the diode load resistor, at points along the a-v-c bus, and at the grids of the r-f or i-f tubes being controlled. *The d-c voltage appearing across the diode load resistor is a very convenient output indication for receiver alignment.*

Measuring Bias-Cell Voltage—Bias-cell voltage can be measured accurately with this instrument. Its high input impedance prevents excessive current drain and consequent damage to cells.

Adjustment of Discriminator Circuits—The voltage developed across the discriminator circuits of f-m receivers or a-f-c circuits can be measured directly at the discriminator, or, in a-f-c circuits, at the grid of the oscillator-control tube.

The zero-center-scale feature of the Master VoltOhmyst is useful in the adjustment of discriminator circuits for zero voltage output. When the discriminator transformer is tuned, the meter pointer swings right or left from the zero-center mark, thus indicating the polarity and the relative amplitude of the d-c voltage developed. As the correct adjustment is approached, the sensitivity of the meter can be increased by setting the VOLTS switch on a lower range, so that the final adjustment will be very accurate.

D-C Supply Voltages—The d-c power-supply voltage can be measured at the rectifier cathode and in the filter circuit; plate voltages at the plates of the various tubes; screen voltages at the screen grids; cathode voltages at the cathodes.

A-C Voltages—The a-c voltmeter is extremely useful in measuring all a-c voltages encountered in the average radio receiver. These voltages include the power-transformer voltages and the audio-frequency voltages developed anywhere from the second-detector load resistor to the speaker voice coil.

The Master VoltOhmyst can therefore be used as an audio-amplifier signal-tracing indicator; it can also be used to measure stage gain or overall gain in an audio amplifier.

Television Receiver Adjustments—This instrument can be used to measure the voltage developed across the picture-channel second-detector load resistor. This measurement is useful in the selection of the optimum orientation and position for the television antenna as well as in the adjustment of antenna matching sections.

Gassy Tubes—The effect of gas in a tube is to cause a voltage, positive with respect to ground, to appear across the tube grid-leak resistor. The effect is to reduce the normal operating bias of the tube, and in some cases even to make the net bias positive, with resultant distortion. In the case of a gassy audio-amplifier tube which is connected directly to the contact arm of the volume control, the grid current due to gas may in time cause the volume control to become noisy. This may happen even though the amount of gas is insufficient to produce a noticeable change in the receiver operation. Consequently, if repeated difficulty is experienced with noisy volume controls in this type of circuit, the Master VoltOhmyst should be used to check for a positive voltage across the grid leak (in this case, between the volume control arm and the low or grounded tap). A positive voltage here may also be caused by a leaky plate-to-grid coupling capacitor; however, if the tube suspected of being gassy is removed and the grid-leak voltage falls to zero, then the tube is definitely gassy.

Pulse Measurements—The peak-to-peak value of voltage pulses can be measured with an accuracy of approximately 2% for pulse-width repetition-rate relations shown graphically in Figure 6. The peak-to-peak value is 2.83 times the reading obtained on the voltage scale (see Figures 2 and 3). For measuring the peak-to-peak values of narrow pulses, the RCA Diode Probe must of course be used as an accessory to the Master VoltOhmyst.

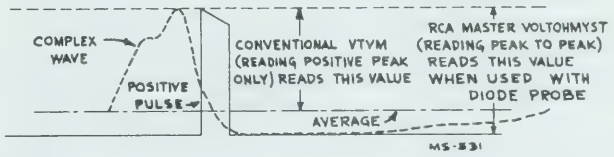

COMPLEX WAVE
POSITIVE PULSE
CONVENTIONAL VTVM (READING POSITIVE PEAK ONLY) READS THIS VALUE
AVERAGE
RCA MASTER VOLTOHMYST (READING PEAK TO PEAK) READS THIS VALUE WHEN USED WITH DIODE PROBE
MS-531

Figure 2

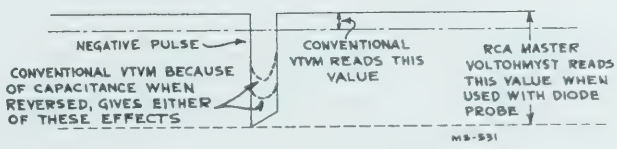

NEGATIVE PULSE
CONVENTIONAL VTVM BECAUSE OF CAPACITANCE WHEN REVERSED, GIVES EITHER OF THESE EFFECTS
CONVENTIONAL VTVM READS THIS VALUE
RCA MASTER VOLTOHMYST READS THIS VALUE WHEN USED WITH DIODE PROBE
MS-531

Figure 3

MAINTENANCE

Although extraordinary care has been taken in the manufacture and design of the RCA Master VoltOhmyst, and despite the fact that each instrument is laboratory tested under strict engineering supervision, it is possible that the instrument may in time require checking and servicing.

To facilitate service, the tube locations, calibration controls, and parts layout are shown in Figure 5. A schematic diagram of the instrument is shown in Figure 7.

The peformance of the Master VoltOhmyst, like that of any other precision instrument, is dependent upon the rating and quality of its components. Therefore, if it becomes necessary to replace a part, the REPLACEMENT PARTS list in this book should be consulted for specifications. Only RCA Replacement Parts or other parts having identical characteristics should be used.

Meter-Pointer Zero Adjustment—The meter pointer should be aligned with the zero marks on the meter scales when the power is off. If it is not, the following check should be made:

Vigorously wipe the meter case window with a clean, soft, dry cloth. If the pointer moves away from zero and remains in a deflected position for several minutes, then the anti-static coating on the inside of the window is ineffective. In this case, the only remedy is to renew the coating. Additional details about this coating material may be obtained by writing to the Test and Measuring Equipment Section, RCA, Camden, New Jersey.

If the meter pointer did not respond to the static test, the following procedure should be used to adjust the mechanical position of the pointer:

1. Unscrew the meter adjustment plug.

2. Insert a scriber or similar tool to engage the meter-pointer adjusting pawls. Move the pawls sideways until the pointer reads exactly zero.

3. Replace the meter adjustment plug.

CAUTION—Extreme care must be taken to prevent insertion of the tool to a depth where it will injure the pointer spring. The guarantee does not cover damage resulting from this adjustment.

Tube Replacement —All tubes are located on the chassis and are accessible for replacement after the rear panel is removed from the case. To remove the rear panel, unscrew the four screws on the rear of the case. To remove the instrument from the case, unscrew the four screws in the corners of the front panel, and the two screws underneath the case, then withdraw the panel-and-chassis assembly.

If it becomes necessary to replace tubes, care should be taken to see that the two RCA-6AK6 tubes are approximately balanced. If they are unbalanced, it will be impossible, when the POLARITY switch is on "+," to bring the pointer to the zeros at the left end of the scale and in the center by means of the ZERO ADJ control. If this should happen, the tubes should be interchanged and the adjustment tried again. If it is still impossible to bring the pointer to zero at both the center and left-hand edge of the meter scale, the tubes have different characteristics and each one should be tried with another tube in order to obtain a matched pair. When the tubes are matched, it will be possible to bring the pointer to zero both at the center of the scale and at the left-hand end of the scale with the ZERO ADJ control. This can be done only when the POLARITY switch is on "+." When this switch is on "–," then it should be impossible to set the pointer to the center-scale zero.

NOTE—Before replacing an RCA-6AK6, age the replacement tube by applying 6.3 volts to its filament for 12 hours.

The circuit design of the Master VoltOhmyst is such that grid current is reduced to a negligible value. However, when replacing tubes, it is advisable to check for grid current as occasionally a gassy tube will be found. The presence of gas is indicated by an appreciable change in the pointer position when the VOLTS switch is changed from "5" to "50" while the SELECTOR switch is in the "DC" position and while no voltage is being measured.

Battery Replacement—Do not allow exhausted batteries to remain in the Master VoltOhmyst. Chemicals leaking from the deteriorated batteries may damage the interior of the instrument. Steel-clad batteries such as the RCA VS-006 are recommended because of their long life and small chance of chemical leakage.

Battery replacement is generally necessary when the ohmmeter readings become unstable, especially on the "RX1" position of the RES/CAP switch. To insure accuracy of the ohmmeter readings, it is suggested that the batteries be checked occasionally as follows:

1. Set the SELECTOR switch to "RES."

2. Set the RES/CAP switch to "RX1," and adjust the RES/CAP ADJ control until the pointer reads full scale.

3. Short circuit the RES/MA and COMMON terminals for about ten seconds.

4. Open the short circuit and immediately observe the meter deflection. A substantial deviation from a full-scale reading indicates that the batteries are weak and should be replaced.

To replace the batteries, remove the rear panel as described under "Tube Replacement," and replace the batteries with two RCA VS-006 1.5-volt cells or the equivalent. The proper position for the cells is shown in Figure 5. Be sure all contacts are clean and tight so that contact resistance will be kept to a minimum.

Calibration—Before adjustments of the calibration controls are made, see that the pointer is mechanically set on zero, and allow the instrument to warm up for 30 minutes. All of the calibration adjustments are located on the rear and left-side aprons of the chassis, and are clearly marked. All calibration adjustments are cemented in place at the factory; the cement can be softened with acetone thinner.

The following procedures are recommended for calibrating the Master VoltOhmyst:

DC + CAL:

1. Set the VOLTS switch on "5," and the POLARITY switch on "+."

2. Set the SELECTOR switch on "DC," and rotate the ZERO ADJ control until the pointer reads zero.

3. Insert the black lead into the COMMON terminal, and the blue probe lead into the VOLTS DC terminal.

4. Connect a standard d-c voltage of four volts between the two test leads. This voltage should be metered with a high-quality, accurate, d-c voltmeter in parallel with the Master VoltOhmyst.

5. Adjust the DC + CAL control until the pointer reads exactly 4 on the scale.

6. Check the accuracy of the instrument on all settings of the VOLTS switch by employing standard voltages of different value on each range. If the accuracy of the meter is not better than ±3% of the full-scale indication on all ranges, then check the multiplier resistors (R17 to 28 incl., R39, 40 and the 1 meg. resistor in the probe) with a reliable bridge.

DC – CAL:

Follow the same procedure given under DC + CAL with the POLARITY switch set on "–," and with the polarity of the standard voltage source reversed. If the various settings of the VOLTS switch checked correctly under the previous DC + CAL test, it will not be necessary to repeat step 6.

AC ZERO; AC CAL:

1. Set the POLARITY switch on "+" or "–," the VOLTS switch on "1," and the SELECTOR switch on "DC."

2. Zero the meter pointer with the ZERO ADJ control.

3. Set the SELECTOR switch on "AC."

4. Plug the a-c probe into the VOLTS AC socket and short-circuit this probe to the COMMON lead.

5. Set the AC ZERO control so that the pointer is aligned with the small red zero on the a-c volts scale.

6. Connect a 60-cycle sine wave of exactly 0.3 volt rms between the a-c probe and the COMMON lead. Adjust the AC CAL control until the meter reads exactly 0.8 volt on the center scale.

7. Check all settings of the VOLTS switch by applying appropriate voltages to the instrument for each setting. If the accuracy is not better than ±3% of the full-scale indication on all ranges, then check the multiplier resistors (R19 to 23 incl., R48 to 51 incl.) with a reliable bridge.

RF ZERO; RF CAL:

1. Set the POLARITY switch on "+" or "–," the VOLTS switch on "5," and the SELECTOR switch on "DC."

2. Zero the meter pointer with the ZERO ADJ control.

3. Set the SELECTOR switch on "RF."

4. Plug the RCA Diode Probe Cable into the VOLTS AC socket and short circuit the probe center-pin to the grounding ring.

5. Set the RF ZERO control so that the meter pointer reads zero. Allow the reading to stabilize, as response to this adjustment is slow.

6. Set the VOLTS switch on "50."

7. Apply a 60-cycle sine wave of exactly 40 volts rms to the probe.

8. Adjust the RF CAL control until the pointer reads exactly 40.

9. Check all settings of the VOLTS switch by applying appropriate voltages to the probe for each setting. Since the multipliers used with the diode probe are the same as those used for d-c voltage measurements, any fault in these multipliers should have been discovered during the DC + CAL test previously described.

CX10 ADJ MAX; CX10 ADJ C.S.; CX100 ADJ MAX:

1. Set the SELECTOR switch on CAP and adjust the ZERO ADJ control for zero pointer reading (small red zero on capacity scale).

2. Set the RES/CAP switch on "CX0.1."

3. Short-circuit the CAP and COMMON terminals, then rotate the RES/CAP ADJ control until the pointer is aligned with the last line on the right-hand side of the top scale.

4. Set the RES/CAP switch to "CX.01." then to "CX.001." The meter should still read full scale.

5. Set the RES/CAP switch to "CX1.0 mf." The meter reading should be within –1.5 divisions of full scale on the center scale.

6. Set the RES/CAP switch to "CX10 mmf." then set the CX10 ADJ MAX trimmer until the meter reads exactly full scale.

7. Remove the short circuit from the CAP and COMMON jacks, and in its place connect a 100-mmf standard capacitor.

8. Set the CX10 ADJ C.S. trimmer for a meter reading of exactly ten on the capacity scale. If this adjustment cannot be made, the capacity-measuring winding on the power transformer probably has excess distributed capacity.

9. Remove the capacitor. The meter should indicate less than two mmf. (less than 0.2 on the capacity scale). If the reading is greater than this, the power transformer probably has a defective shield.

10. Set the RES/CAP switch to "CX100 mmf." and short-circuit the CAP and COMMON terminals.

11. Set the CX100 ADJ MAX trimmer for a full-scale meter reading.

12. Remove the short circuit and in its place connect a 1000-mmf standard capacitor. The meter reading should not differ from the capacitor value by more than ±10%.

13. Remove the capacitor. The meter should read less than one scale division.

Replacing Diode in Diode Probe—Failure of the RCA 6AL5 diode in the Diode Probe will normally cause the meter to deflect sharply to the left when the SELECTOR switch is on "RF." An open filament can usually be detected by feeling the probe since the diode heater warms the probe body slightly. RF calibration should be checked whenever the diode is replaced.

To gain access to the RCA-6AL5 in the probe for examination or replacement refer to Figure 4 and proceed as follows:

CAUTION—Do not attempt to unscrew the knurled ring on the probe front until step 6 of the following procedure has been completed.

1. Unscrew the streamlined cap from the rear of the probe and push cap, washer, and bakelite cover back over the cable.

2. Unscrew the hex nut at the rear of the probe, being careful not to turn the bushing with respect to the metal probe body.

3. Push the bushing into the probe body far enough to disengage the locking pin.

4. Unscrew the rear half of the probe body from the front half, and push the rear half back over the cable. The 6AL5 will then be exposed, making examination or replacement possible.

5. If it is necessary to remove the diode socket and capacitor assembly, unscrew the threaded bushing which holds the two halves of the probe together. This operation is facilitated by inserting a nail or some similar instrument through the holes in the bushing.

6. Heat the probe tip with a soldering iron until the solder is melted, then withdraw the diode socket and capacitor assembly from the rear of the front half of the probe body.

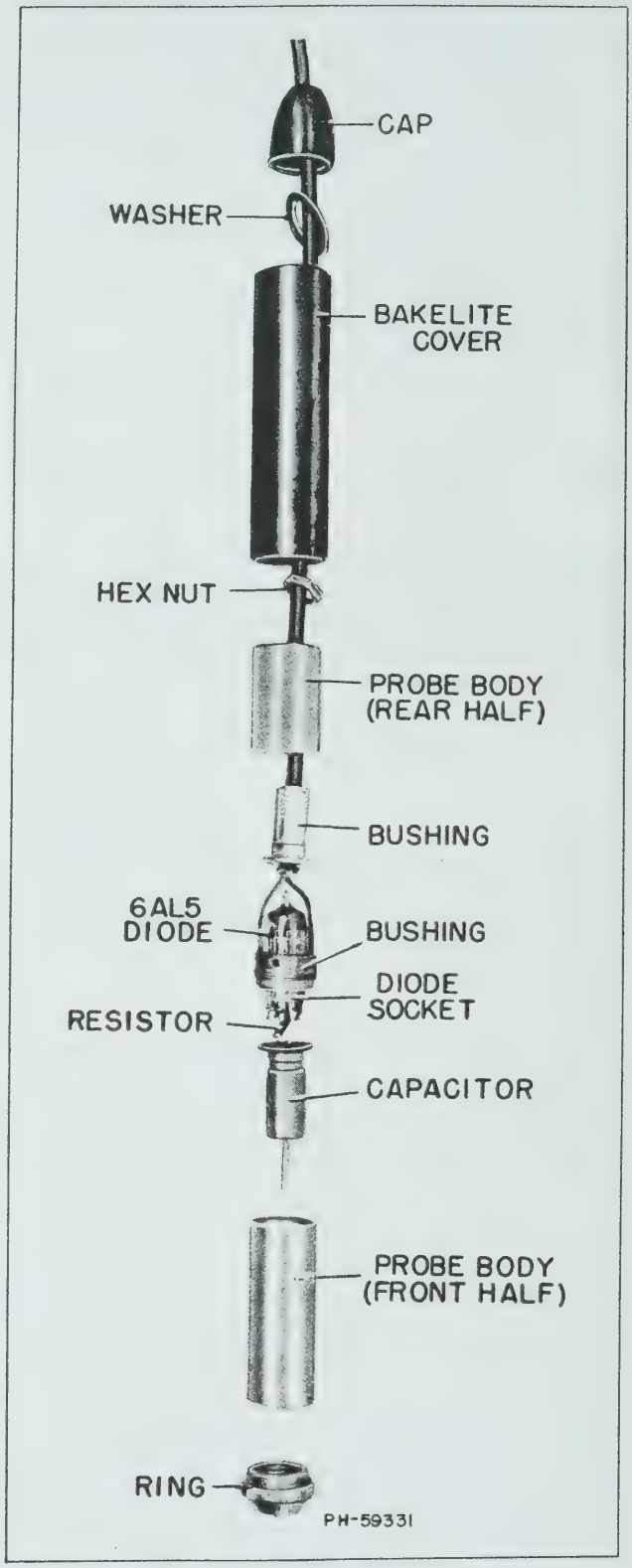


Figure 4—Exploded View of RCA Diode Probe

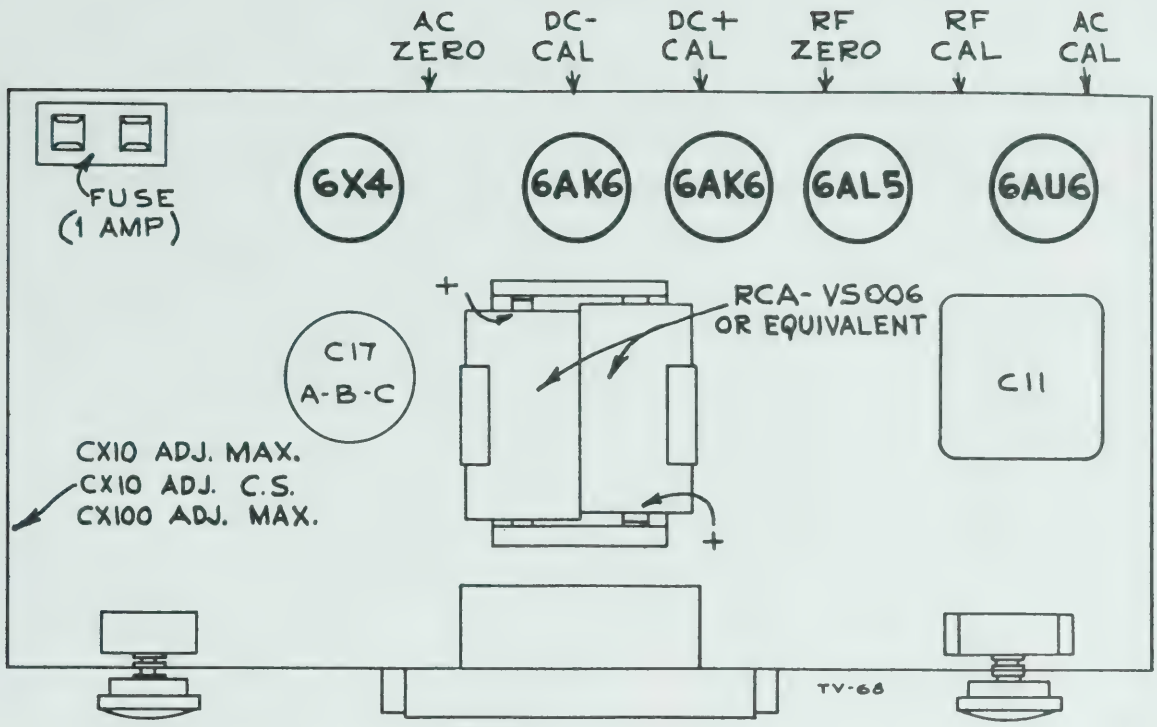


Figure 5—Tube and Adjustment Layout

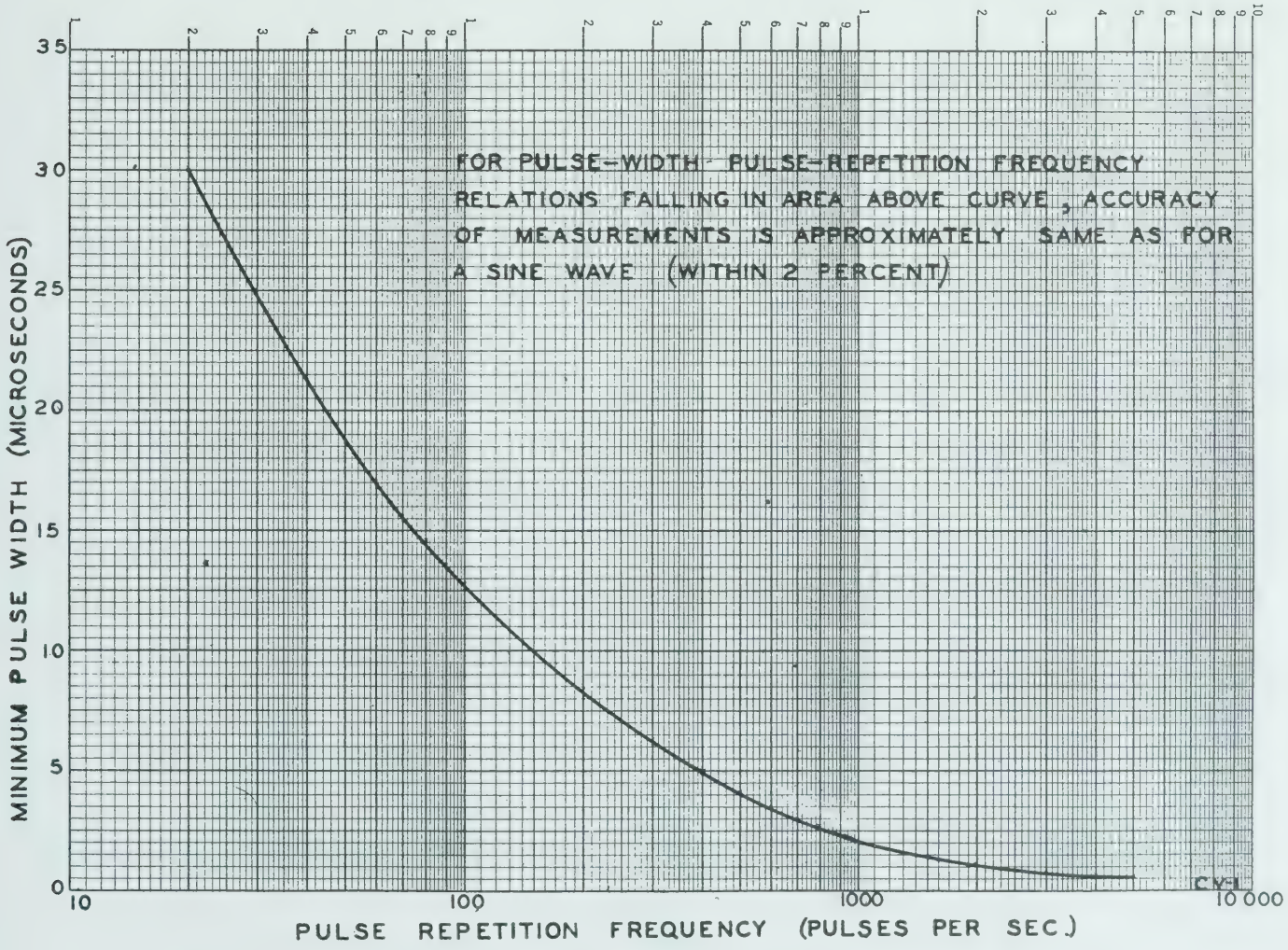


Figure 6—Pulse-Width Repetition-Rate Relation Curve for Use with RCA Diode Probe

SYMBOL	SWITCH FUNCTION	POSITION 1	POSITION 2	POSITION 3	POSITION 4	POSITION 5	POSITION 6	POSITION 7
S1	SELECTOR	CURRENT	D.C. VOLTS	R.F. VOLTS	A.C. VOLTS	CAPACITY	RESISTANCE	———
S2	RES/CAP RANGE	R X 1 C X 10 MMFD	R X 10 C X 100 MMFD	R X 100 C X .001 MFD	R X 1000 C X .01 MFD	R X 10,000 C X .1 MFD	R X 1 MEG C X 1 MFD	———
S3	VOLTS RANGE	1 VOLT (A.C. ONLY)	5 VOLTS	10 VOLTS	50 VOLTS	100 VOLTS	500 VOLTS	1000 VOLTS
S4	CURRENT RANGE	10 μA	100 μA	1 M.A.	10 M.A.	100 M.A.	1-10 AMPS	———
S5	POWER & POLARITY	(POWER) OFF	(D.C.) +	(D.C.) −	———	———	———	———

ALL RESISTANCE VALUES IN OHMS.
ALL CAPACITANCE VALUES BELOW ONE IN MF. AND ABOVE ONE IN MMF UNLESS OTHERWISE NOTED.

ARROWS AT CONTROLS INDICATE CLOCKWISE ROTATION

ALL SWITCH SECTIONS VIEWED FROM FRONT OR KNOB END OF SWITCH

ROTORS SHOWN IN EXTREME COUNTER CLOCKWISE (LEFT) POSITION

SWITCH LEGEND

DUMMY LUGS
LONG LUG
SHORT LUG
INSULATED LUG
THROUGH ELECTRICAL CONNECTION
THROUGH ELECTRICAL CONNECTION

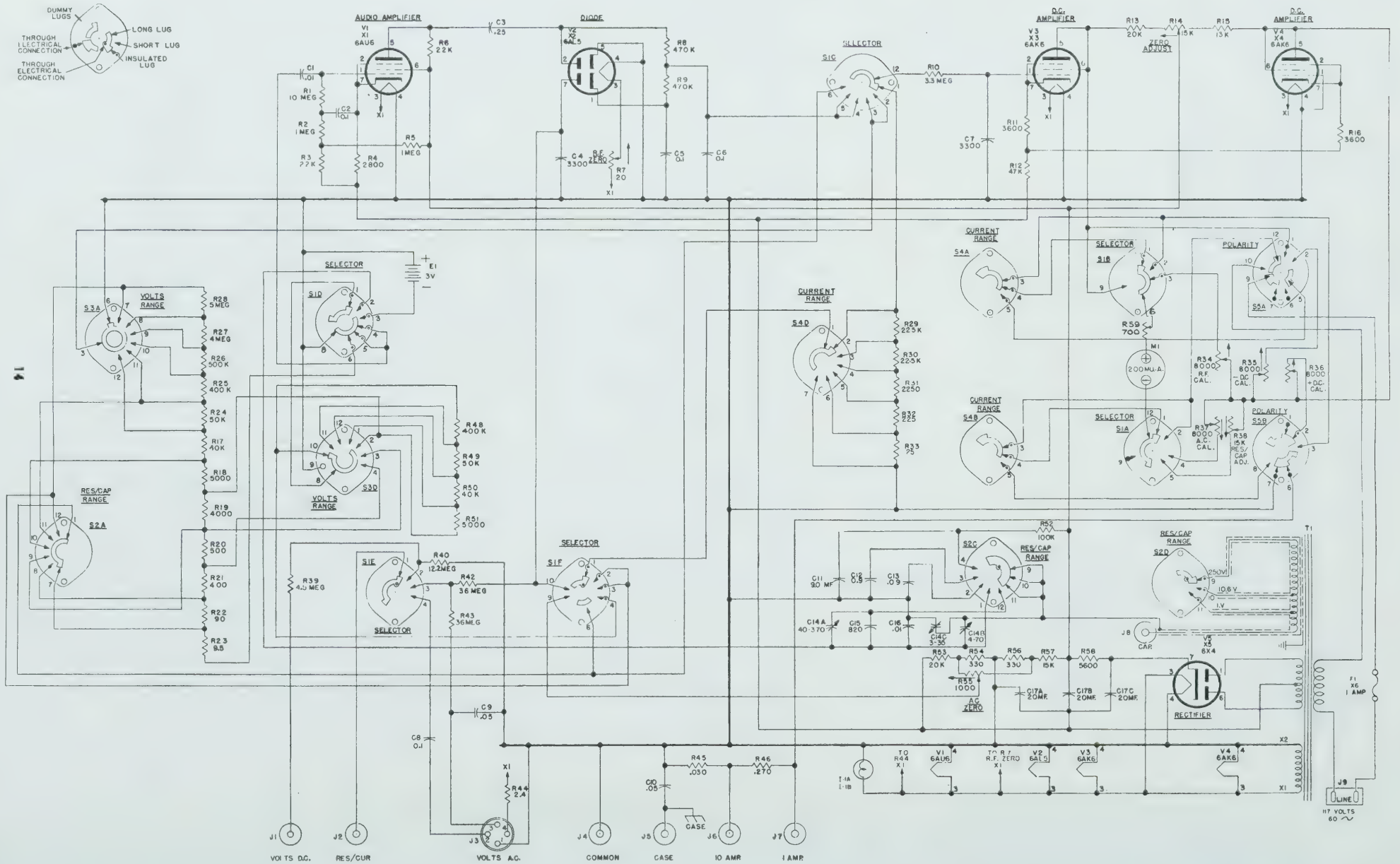


Figure 7—Schematic Circuit Diagram

REPLACEMENT PARTS LIST

TYPE WV-95A MASTER VOLTOHMYST

SYMBOL NO.	DESCRIPTION	STOCK NO.
C-1	Capacitor—Paper Tubular, .01 mfd., 20% 400 Volts	70610
C-2	Capacitor—Paper Tubular, .1 mfd., 20%, 200 Volts	70617
C-3	Capacitor—Paper Tubular, .25 mfd., 20%, 400 Volts	70618
C-4	Capacitor—Fixed Mica, 3300 mmfd., 20%, 500 Volts	39664
C-5, 6	Same as C-2	
C-7	Same as C-4	
C-8	Capacitor—Paper Tubular, .1 mfd., 20%, 600 Volts	70639
C-9	Capacitor—Paper Tubular, .05 mfd., 20%, 400 Volts	70615
C-10	Capacitor—Paper Tubular, .05 mfd., 20%, 1000 Volts	70657
C-11	Capacitor—Paper, Steel Case, 9.0 mfd., 5%, 100 V. D. C.	55847
C-12	Capacitor—Paper Tubular, 0.9 mfd., 5%, 100 Volts	55848
C-13	Capacitor—Paper Tubular, .09 mfd., 5%, 100 Volts	55875
C-15	Capacitor—Fixed Mica, 820 mmfd., 5%, 500 Volts	39650
C-14A, B, C	Capacitor—Variable Trimmer, 40-370 mmfd., 4-70 mmfd., 3-35 mmfd.	56179
C-16	Capacitor — Fixed Mica, 10,000 mmfd., 5%, 300 Volts	92036
C-17A, B, C	Capacitor—Dry Electrolytic, 20-20-20 mfd., 150 Volts	37637
F-1	Fuse—Glass Tubular, 1 Ampere	14133
I-1A	Lamp—Pilot Lamp	11891
I-1B	Socket—Pilot Light Socket Assembly	54495
J-1	Connector—Chassis, with Terminal and Int. Tooth, Volts DC	68439
J-2, 6, 7, 8	Jacla—Pin, RES/MA., CAP., 10 AMP., 1 AMP. (Red)	55238
J-3	Connector—Chassis, 4 Contact (Female) Volts AC	52823
J-4, 5	Jack—Pin, Common, Case (Blue)	55239
J-9	Plug—Chassis, Line Voltage, 2 Contacts (Male)	71448

SYMBOL NO.	DESCRIPTION	STOCK NO.
M-1	Meter—200 Microamps. Complete with Case and Scale	55845
R-1	Resistor — Fixed Composition, 10 Megohms, 20%, ½ Watt	
R-2	Resistor — Fixed Composition, 1.0 Megohm, 20%, ½ Watt	
R-3	Resistor—Fixed Composition, 22,000 Ohms, 5%, ½ Watt	
R-4	Resistor—Fixed Composition, 2800 Ohms, 1%, ½ Watt	55850
R-5	Resistor — Fixed Composition, 1 Megohm, 5%, ½ Watt	
R-6	Resistor—Fixed Composition, 22,000 Ohms, 1%, ½ Watt	55851
R-7	Resistor — Variable, Wire Wound, RF Zero, 20 Oms, 2 Watt	52822
R-8, 9	Resistor — Fixed Composition, 470,000 Ohms, 5%, ½ Watt	
R-10	Resistor — Fixed Composition, 3.3 Megohms, 20%, ½ Watt	
R-11	Resistor—Fixed Composition, 3600 Ohms, 1%, ½ Watt	55852
R-12	Resistor—Fixed Composition, 47,000 Ohms, 1%, ½ Watt	55853
R-13	Resistor—Fixed Composition, 20,000 Ohms, 5%, ½ Watt	
R-14	Resistor — Variable, Composition, RES/CAP ADJ, 15,000 Ohms, Linear Curve	55844
R-15	Resistor—Fixed Composition, 13,000 Ohms, 5%, ½ Watt	
R-16	Same as R-11	
R-17	Resistor—Fixed Composition, 40,000 Ohms, 1%, ½ Watt	55854
R-18	Resistor—Fixed Composition, 5,000 Ohms, 1%, ½ Watt	55855
R-19	Resistor—Fixed Composition, 4,000 Ohms, 1%, ½ Watt	55856
R-20	Resistor — Fixed Composition, 500 Ohms, 1%, ½ Watt	55857
R-21	Resistor — Fixed Composition, 400 Ohms, 1%, ½ Watt	55858
R-22	Resistor — Fixed Composition, 90 Ohms, 1%, ½ Watt	55859
R-23	Resistor — Fixed Composition, 9.5 Ohms, 1%, ½ Watt	55860

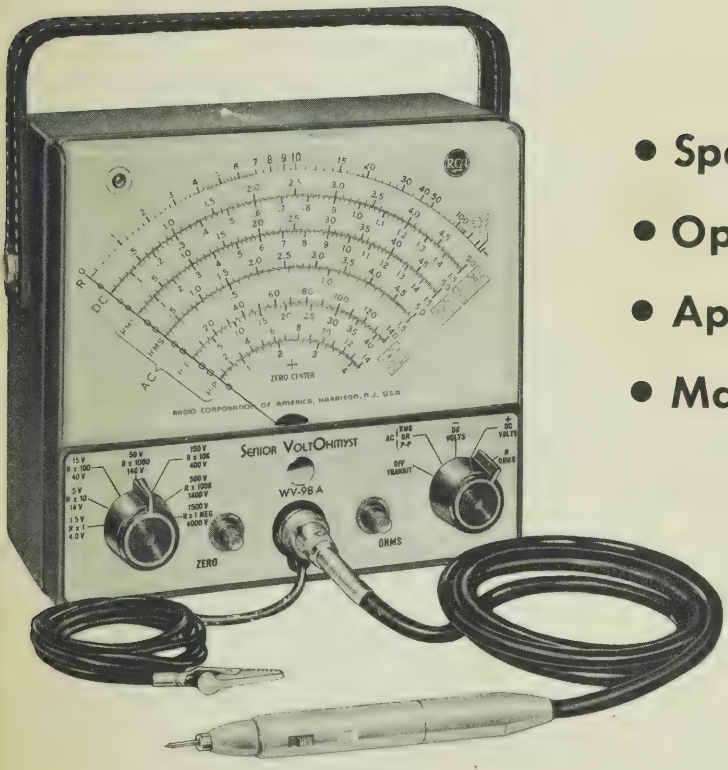
REPLACEMENT PARTS LIST (CONTINUED)

SYMBOL NO.	DESCRIPTION	STOCK NO.
R-24	Resistor—Fixed Composition, 50,000 Ohms, 1%, ½ Watt	55861
R-25	Resistor—Fixed Composition, 400,000 Ohms, 1%, ½ Watt	55862
R-26	Resistor—Fixed Composition, 500,000 Ohms, 1%, ½ Watt	52819
R-27	Resistor — Fixed Composition, 4.0 Megohms, 1%, 1 Watt	55863
R-28	Resistor — Fixed Composition, 5.0 Megohms, 1%, 1 Watt	55864
R-29	Resistor—Fixed Composition, 225,000 Ohms, 1%, ½ Watt	55865
R-30	Resistor—Fixed Composition, 22,500 Ohms, 1% ½ Watt	55866
R-31	Resistor—Fixed Composition, 2250 Ohms, 1%, ½ Watt	55867
R-32	Resistor — Fixed Composition, 225 Ohms, 1%, ½ Watt	55868
R-33	Resistor — Fixed Composition, 25 Ohms, 1%, ½ Watt	55869
R-34, 35, 36 37	Resistor — Variable, Wire Wound, 8000 Ohms	43916
R-38	Same as R-14	
R-39	Resistor — Fixed Composition, 4.5 Megohms, 1%, 1 Watt	55870
R-40	Resistor—Fixed Composition, 12.2 Megohms, 1%, 1 Watt	55871
R-42, 43	Resistor — Fixed Composition, 36 Megohms, 1%, 1 Watt	55872
R-44	Resistor—Wire Wound, 2.4 Ohms, 10%	51953
R-48	Resistor—Fixed Composition, 400,000 Ohms, 1%, 2 Watt	55873
R-49	Same as R-24	
R-50	Same as R-17	
R-51	Same as R-18	
R-52	Resistor—Fixed Composition, 100,000 Ohms, 20%, ½ Watt	
R-53	Same as R-13	
R-54	Resistor — Fixed Composition, 330 Ohms, 5%, ½ Watt	
R-55	Resistor — Variable, Composition, AC ZERO, 1000 Ohms	53863
R-56	Same as R-54	
R-57	Resistor—Fixed Composition, 15,000 Ohms, 5%, ½ Watt	
R-58	Resistor—Fixed Composition, 5600 Ohms, 10%, ½ Watt	
R-59	Resistor—Adjustable Wire Wound, Overall Resistance—700 Ohms, 10%, 2 Watt	55874
S-1A, B, C D, E, F	Switch — Selector, Rotary Wafer Type, 3 Sections, 8 Circuit, 6 Positions	55840
S-2A, C, D	Switch — RES/CAP Range, Rotary Wafer Type, 2 Sections, 3 Circuits	55842
S-3A, S-3D	Switch — VOLTS Range, Rotary Wafer Type, 2 Sections, 2 Circuit, 7 Positions	55841
S-4A, B, L	Switch—CURRENT Range, Rotary Wafer Type, 2 Sections, 6 Positions	55839
S-5A, B	Switch — POLARITY, Rotary Wafer Type, 1 Section, 5 Circuit, 3 Positions	55843
T-1	Transformer—Power, Pri.-117 Volt, 50/60 Cycle	56127
	Sec. No. 1—5.7 V., 1.63 Amp.	
	Sec. No. 2—94 V. (DC) 60 Ma.	
	Sec. No. 3—Tapped for 1.0 V., 4 Ma., 10.64 V. and 250 Volt	
X-1, 2, 3, 4, 5	Socket—Tube, Miniature, 7 Contacts	73115
	Board—Fuse Mounting	55316
	Case—Meter	55846
	Handle—Carrying Handle	53704
	Knob—Large, for ZERO ADJ, POLARITY, RES/CAP, VOLTS, SELECTOR, CURRENT	53683
	Knob—Small, RES CAP ADJ Control (Blue)	53689
	Plate—Capacitor Mounting	28452
	Pointer—For Large Control Knob.	53684

PRICE ONE DOLLAR

RCA SENIOR VOLTOHMYST®

Type WV-98A



- Specifications
- Operation
- Applications
- Maintenance

RADIO CORPORATION of AMERICA
ELECTRON TUBE DIVISION
HARRISON, N. J.

ITEMS
Supplied with the WV-98A

1 DC/AC-OHMS Probe and Cable..... Type WG-299C
1 1.5-Volt Battery.....Type VS036
1 Slip-on Alligator Clip 1 Insulator
1 RCA-6AL5 Tube 1 RCA-12AU7 Tube
1 Instruction Booklet for WV-98A
1 Registration Card

ACCESSORIES
Available on Separate Order

For measuring AC Voltages at Frequencies from 50 Kc to 250 Mc:
Crystal-Diode Probe.....Type WG-301A
For increasing DC Voltage Range to 50,000 Volts:
High-Voltage Probe.....Type WG-289
Multiplier Resistor.....Type WG-206

NOTE
The types WG-299A, WG-299B, and WG-299C DC/AC-OHMS Probe and Cables can be used interchangeably with the WV-98A.

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TEST AND MEASURING EQUIPMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

Instr. WV-98A (4) 11-58
Printed
in U. S. A.

Senior VoltOhmyst
Type WV-98A

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Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. For proper operation, the ground terminal of the instrument should always be connected to the ground of the equipment under test. The WG-299C DC/AC-OHMS Probe and Cable has a shield throughout its entire length which is connected to the instrument ground and case. Always handle the WG-299C by the insulated probe housing.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be *especially careful* to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

General Description

The WV-98A Senior VoltOhmyst* is an all electronic voltmeter designed to measure dc voltages, resistance, rms values of sine waves, and peak-to-peak values of complex waves. Both rms ac and dc voltages up to 1500 volts may be measured in seven ranges with an accuracy of ±3% of full scale. Resistance values up to 1000 megohms, and complex waveforms having peak-to-peak values up to 4200 volts may also be measured. All measurements are made on a 6½ inch burn-out-proof meter. Separate scales for each function provide improved visibility and permit more accurate readings between scale divisions.

An input resistance of 11 megohms on all dc-voltage ranges allows the WV-98A to be used in circuits where instruments with a lower impedance would result in loading of the circuit under test and a resultant error in reading the operating voltage. The 11-megohm input resistance also has the advantage of not being so high as to impair the stability of the instrument.

The WV-98A is frequency compensated for ac-voltage ranges up to and including the 500-volt range (500 rms volts or 1400 peak-to-peak volts) and can be used at frequencies up to approximately 3 megacycles, depending upon the impedance of the source voltage. (The extended frequency range of the Senior VoltOhmyst, coupled with its high sensitivity, makes it a convenient and reliable device for use in rf applications.) The impedance on ac measurements is a minimum of 0.83 megohm.

Calibration of the Senior VoltOhmyst in peak-to-peak voltage values as well as rms voltage values is a desirable feature for applications such as television, radar, and other pulsed electronic systems where complex waveforms are encountered. Because the meter reading is proportional to the full peak-to-peak value of the waveform, a better indication of the true value of the voltage is given than is possible with voltmeters which respond only to the positive or negative peak of the waveshape. Peak-to-peak voltage values are measured directly on separate meter scales.

When used to measure resistance, the WV-98A will read from 0.2 ohm to 1000 megohms in seven ranges. Convenient mid-scale values are set at 10, 100, 1000, 10,000, and 100,000 ohms and at 1 and 10 megohms.

All measurements are made with a new single-unit probe, the WG-299C DC/AC-OHMS Probe and Cable. The probe is quickly adapted to either dc measurements, or ac and resistance measurements by means of a built-in switch. A fixed ground lead connected to the chassis of the WV-98A insures good grounding of the circuit under test.

The WV-98A is housed in a smartly-styled diecast aluminum case. The light-

*Trade Mark "VoltOhmyst" Reg. U. S. Pat. Off.

weight probe and cable supplied with the WV-98A has been designed to match the mechanical and electrical characteristics of the instrument.

Additional features of the WV-98A include provision for zero-centering of the meter pointer, a useful feature for checking FM discriminator alignment; two separate scales for low-voltage ac measurements; a pilot light; and circuit design which permits measurements of the ac component of a dc voltage or the dc component of an ac signal. Circuit design also prevents any dc-loading effect when the WV-98A is used to measure ac voltages.

For measurement of ac voltages at frequencies up to 250 megacycles, the auxiliary WG-301A Crystal-Diode Probe may be used. The WG-301A slips on the front end of the WG-299C to form a sturdy, insulated rf probe without the addition of an extra cable. When the auxiliary WG-289 High-Voltage Probe is connected to the input terminal of the Senior VoltOhmyst, dc voltages up to 50,000 volts may be measured.

The RCA WV-98A Senior VoltOhmyst is a versatile instrument, designed to give quality performance. A reliable measuring device, it enables the user to make a wide variety of accurate electrical measurements in many kinds of electrical equipment.

Specifications

Electrical

NOTE: Performance figures are for line voltage of 117 volts, 60 cps.

DC Voltmeter:

Ranges ..... 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance (With switch on WG-299C set to "DC"):
All Ranges ..... 11 Megohms
Sensitivity on 1.5-V Range ..... 7.3 megohms/volt
Over-all Accuracy ..... ±3% of full scale

AC Voltmeter:

Ranges:
RMS Values of Sine Waves ..... 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Peak-to-Peak Values of Sine Waves & Complex Waves ..... 0 to 4, 14, 42, 140, 420, 1400, 4200 volts
Over-all Accuracy ..... ±3% of full scale
Input Resistance and Capacitance
(With switch on WG-299C set to "AC-OHMS"):
1.5, 5, 50, 150-V Ranges ..... 0.83 meg. shunted by 70 $\mu\mu$f
500-V Range ..... 1.3 meg. shunted by 60 $\mu\mu$f
1500-V Range ..... 1.5 meg. shunted by 60 $\mu\mu$f

Frequency Response:

NOTE: The response data below are for the 1.5, 5, 15, 50, 150, and 500 volt ranges. The 1500-volt range is flat at power-line frequencies.

(With switch on WG-299C set to "AC-OHMS"):

For source impedance of approximately 100 ohms.....30 cps to 3 Mc□
For source impedance of approximately 1000 ohms.....30 cps to 500 Kc△
For source impedance of approximately 5000 ohms.....30 cps to 270 Kc○
For source impedance of approximately 10,000 ohms.....30 cps to 80 Kc♦
With Crystal Probe WG-301A•.....within 10% from 50 Kc to 250 Mc

Maximum Input Voltages:

DC Voltages with no ac voltage present:.....1500 volts
AC Voltages with no dc voltage present:
RMS for Sine Waves.....1500 volts
Peak-to-Peak for Sine Waves.....4200 volts
Peak-to-Peak for Complex Waves.....2000 volts
Combined AC and DC Voltages:
Sum of DC Voltage and AC Peak Voltage.....2000 volts

Ohmmeter:

Ranges, Seven.....0 to 1000 megohms

Meter Movement:

DC Current for Full-Scale Deflection.....200μ amperes

Power Supply:

Voltage Rating.....105-125 volts
Frequency Rating.....50/60 cps
Power Consumption (Approx.).....6 watts
Battery (1.5-volt cell).....1 RCA-VSO36

Tube Complement:.....1 RCA-6AL5, 1 RCA-12AU7

Mechanical

Over-all Dimensions:

Height.....6½ inches
Width.....7 inches
Depth.....3¾ inches

Weight:.....6 pounds

Finish:.....Blue-grey hammeroid case—satin aluminum panel

□ Response is up about 10% at 3 Mc.
△ Response is up about 10% at 500 Kc.
○ Response is down about 10% at 270 Kc.
♦ Response is down about 10% at 80 Kc.
• Available on separate order.

Functions of Controls

FUNCTION SELECTOR—Applies power to the instrument when this control is turned clockwise from the "OFF-TRANSIT" position and selects the measurement function of the instrument. When this switch is set to the "OFF-TRANSIT" position, power is removed and, a short is placed across the meter terminals to lock meter pointer electrically in the zero position, thereby reducing the possibility of damage to the meter movement when the instrument is being transported.

RANGE SELECTOR—Selects the ac- or dc-voltage range or the resistance range on which the measurement is to be made.

ZERO control—Used to position the meter pointer at either the left-hand "0" position or, when function selector is set to "+DC VOLTS", to the zero-center "0" position.

OHMS control—Used to position the meter pointer at the extreme right line on the "R" scale when the function selector is set to "R OHMS". NOTE: The WG-299C DC/AC-OHMS Probe and Cable is used for all measurements. The cable connector attaches to the front-panel connector of the WV-98A. The ground cable, which is permanently attached to the instrument, is connected directly to the chassis and serves as a common return point for all resistance and ac- and dc-voltage measurements.

Operation and Application

Use of WG-299C Probe and Cable:

The WG-299C DC/AC-OHMS Probe and Cable, supplied with the WV-98A, is constructed as a single-unit probe and cable and is equipped with a sliding switch in the probe body to permit changing the probe characteristics to suit the type of measurement being made. When the sliding switch is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the WV-98A. This resistor acts to isolate the instrument from the circuit under test when dc-voltage measurements are made and is a part of the over-all input resistance of the voltmeter. The switch should always be set to the "DC" position when dc-voltage measurements are made and when the WG-301A Crystal-Diode Probe is used.

When the sliding switch is set to the rear or "AC-OHMS" position, the isolating resistor is shorted out and the signal or test voltage is fed directly from the probe tip to the input of the WV-98A. The switch should always be set to the "AC-OHMS" position when resistance or ac-voltage measurements are made.

Preliminary Adjustments:

To prepare the WV-98A for use, make the following connections and adjustments:

1. Connect the WG-299C DC/AC-OHMS Probe and Cable to the front-panel connector.

2. Plug the power cord into an ac outlet supplying 105-125 volts at 50-60 cps and adjust the controls as follows:

a. Set the function selector to "+DC VOLTS" and allow a few minutes for the instrument to warm up.

b. Adjust the ZERO control to position the meter pointer at the left-hand zero on the scales.

c. Turn the function selector to "R OHMS". The pointer should deflect to approximately full scale.

d. Rotate the OHMS control to position the pointer at the last line on the "R" (ohms) scale.

e. Turn the function selector to the "AC" position, and set the range switch to the "1.5V" position. The pointer should deflect back to the left-hand zero. The instrument is now ready for use.

Use of Range Switch and Meter Scales:

The meter scales on the WV-98A have been designed to provide ease of operation and quick readability over a wide range of measurements. Scales have been grouped according to the type of measurement for which they are used. The "R" scale, at the top of the scale plate, is used only for resistance measurements, and all resistance measurements are read from this one scale. All dc voltages are read from the two scales marked "A" and "B" in Figure 1. The eight remaining scales are used only for ac-voltage measurements. The rms values of sine-wave voltages are read from scales marked "C", "D", "E", and "F". The corresponding peak-to-peak values are read from scales marked "G", "H", "J", and "K". The particular scale which is used for any given function is determined by the setting of the range switch.

Table I has been prepared as an aid in selection of ranges, scales, and multiplying factors for all measurements which can be made with the WV-98A.

Because of the wide number of measurement ranges provided on the WV-98A, it is often possible to take voltage or resistance reading on two ranges and scales. For greatest accuracy in voltage measurements, always use the range which will provide an on-scale reading which is nearest to the full-scale point. For example, 48 dc volts can be read from either the 50-volt or the 150-volt range. Because the

(continued on page 12)

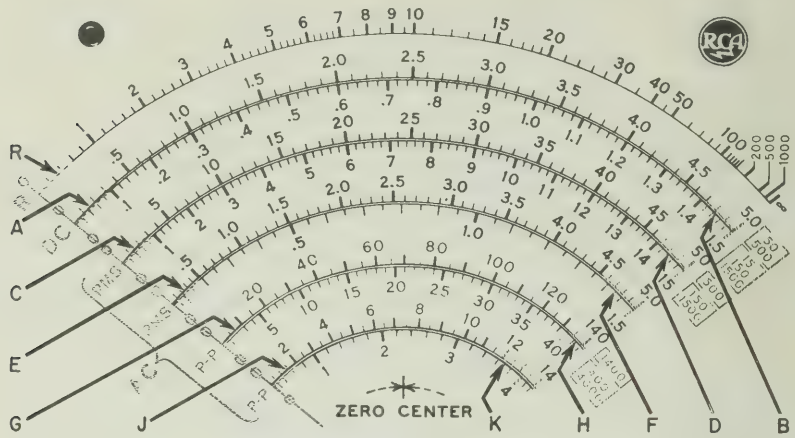


Figure 1. WV-98A meter scales

TABLE 1
RESISTANCE MEASUREMENTS

(Set Function switch to "R OHMS" and set WG-299C switch to "AC-OHMS".)

Resistance to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 1000Ω	R X 1	R	1
1000 to 10000Ω	R X 10	R	10
10000 to 100000Ω	R X 100	R	100
100000Ω to 1 MEG	R X 1000	R	1000
1 MEG to 10 MEG	R X 10K	R	10000
10 MEG to 100 MEG	R X 100K	R	100000
100 MEG to 1000 MEG	R X 1 MEG	R	1 MEG

DC VOLTAGE MEASUREMENTS

(Set Function switch to "−DC VOLTS" or "+DC VOLTS" and set WG-299C switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.02 to 1.5V	1.5V	B	1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	10
15 to 50V	50V	A	10
50 to 150V	150V	B	100
150 to 500V	500V	A	100
500 to 1500V	1500V	B	1000

AC RMS VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299C switch to "AC-OHMS".)

RMS voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent peak-to-peak value: Use Scale	Multiply by
0.1 to 1.5V	1.5V	F	1	K	1
1.5V to 5V	5V	E	1	J	1
5 to 15V	15V	D	1	H	1
15 to 50V	50V	C	1	G	1
50 to 150V	150V	D	10	H	10
150 to 500V	500V	C	10	G	10
500 to 1500V	1500V	D	100	H	100

AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299C switch to "AC-OHMS".)

Peak-to-peak voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent RMS value: Use Scale	Multiply by
0.2 to 4V	4.0V	K	1	F	1
4 to 14V	14V	J	1	E	1
14 to 40V	40V	H	1	D	1
40 to 140V	140V	G	1	C	1
140 to 400V	400V	H	10	D	10
400 to 1400V	1400V	G	10	C	10
1400 to 4200V	4000V	H	100	D	100

NULL INDICATIONS (DC VOLTS)

(Set Function switch to "+DC VOLTS" and set WG-299C switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
—.75 to +.75V	1.5V	B	1
—2.5 to +2.5V	5V	A	1
—7.5 to +7.5V	15V	B	10
—25 to +25V	50V	A	10
—75 to +75V	150V	B	100
—250 to +250V	500V	A	100
—750 to +750V	1500V	B	1000

50-volt range will provide a reading nearest the full-scale point, the 50-volt range only should be used if a reading of best accuracy is to be obtained. This general rule applies to all ac- and dc-voltage ranges. For ohms measurements, however, the range selected should be the one which provides a reading nearest the *center* of the scale because the VoltOhmyst provides the most accurate readings at mid-scale points.

For some measurements it will be necessary to use a multiplying factor with the scale reading to obtain the correct reading. The required multiplier is indicated by the setting of the range switch. These ranges correspond to the full-scale values shown on the right side of the meter scales. For example, when the range switch is set to the 500-volt position for a dc-voltage measurement, the "A" scale (Figure 1) is used. Because this scale has a full scale value of "5", it is necessary to multiply any readings on this scale by 100 to obtain the correct value.

DC-Voltage Measurements:

NOTE: The sliding switch on the WG-299C should be set to "DC" for all dc-voltage measurements. Maximum input voltages must not be exceeded. See "Specifications" and "Safety Precautions".

The WV-98A has seven dc-voltage ranges: 0 to 1.5, 5, 15, 50, 150, 500, and 1500 volts. Although the meter is protected against burn-out under ordinary overloads, it is good practice to make a trial measurement at a range setting higher than the voltage expected. Continued or repeated overloads may impair the accuracy of the movement. To measure dc voltages, proceed as follows:

1. Set the function selector to "+DC VOLTS" or to "—DC VOLTS", as required.
2. Connect the clip of the ground cable to ground.
3. Set the range selector to a range position higher than the voltage to be measured.
4. Touch or connect the probe tip to the high side of the source voltage.
5. Reset range selector to a position which gives a reading nearest to full scale.
6. Read the dc voltage from the scale corresponding to the range selector setting.

Zero-Center Indication:

Zero-center indication is frequently useful because it allows observation of either positive or negative dc-voltage excursions without the necessity of resetting the function selector.

1. Set the function selector to "+DC VOLTS".
2. Rotate the ZERO control to position the pointer at the center "⟷", which is located near the bottom center of the meter dial. If the ZERO control does not have sufficient range to center the pointer, switch the function selector to "—DC VOLTS".
3. Set the range selector to a position at least twice the voltage to be measured.
4. After a test reading has been made, the range control may be set to the lowest position which allows the pointer to remain on the scale.

Resistance Measurements:

NOTE: The sliding switch on the WG-299C probe should always be set to "AC-OHMS" when resistance measurements are to be made. Before resistance measurements are made, the power should be removed from the equipment under test, and any capacitors should be discharged so that no voltages are present on them.

1. Set the function selector to the "R OHMS" position.
2. Set the range selector to the "R x 10" position.
3. Short the probe tip to the ground cable and adjust the ZERO control to position the pointer at the left-hand "0", if necessary.
4. Separate the probe tip from the ground cable. The meter pointer should deflect to full scale. If the meter pointer does not deflect to exactly full scale, use the OHMS control to obtain full deflection.
5. Connect the clip of the ground cable to one terminal of the resistance to be measured.
6. Touch or connect the probe tip to the other terminal of the resistance to be measured.
7. Reset the range control to give a convenient deflection on the "R" (ohms) scale.
8. Multiply the reading on the "R" scale by the factor indicated by the range control setting.

CAUTION: Low-current, low-resistance devices, such as thermocouples and meter movements, may be damaged unless a range higher than "R x 10" is used because the WV-98A applies up to 1.5 volts across the resistance under measurement when the range control is set at "R x 1" or "R x 10".

Measurement of Resistance Values Above 1000 Megohms.

The leakage resistance of small mica and paper capacitors is usually above 1000 megohms. The circuit shown in Figure 2 can be used to measure resistance values above 1000 megohms. An external dc-voltage source between 20 and 500

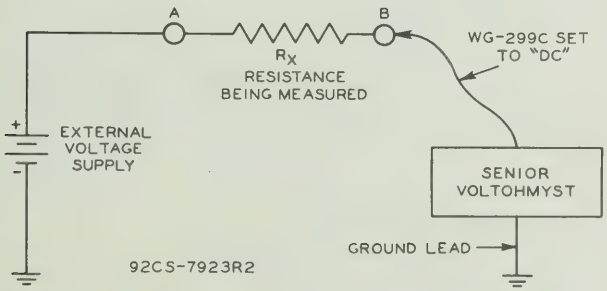


Figure 2. Circuit for resistance measurements above 1000 megohms

volts is utilized to obtain a measurable pointer deflection. Make circuit connections as shown in Figure 2 and proceed as follows:

1. Set function selector to "+DC VOLTS" and measure the voltage at point B.
2. Measure the voltage at point A.
3. Compute the unknown resistance from the following formula:

$$\text{Rx (megohms)} = \frac{11\ [(\text{Volts at "A"}) - (\text{Volts at "B"})]}{(\text{Volts at "B"})}$$

EXAMPLE: The value of an unknown resistance is to be determined with the circuit of Figure 2. An external voltage of 500 volts is applied. The WV-98A measures 2.5 volts at "B", and 500 volts at "A". Then,

$$\text{Rx} = \frac{11\ (500\text{-}2.5)}{2.5} = 2200 \text{ megohms (approx.)}$$

AC-Voltage Measurements:

CAUTION: Maximum input voltages must not be exceeded. The accuracy of meter indications is dependent upon the frequency of the ac voltage being measured, the waveshape, repetition rate, and the impedance of the voltage source. See "Specifications", page 6, and the section below for additional information.

The switch on the WG-299C Probe should be set to "AC-OHMS" for all ac-voltage measurements.

1. Set the function selector to "AC".
2. Adjust the ZERO control if necessary to position the meter pointer at the left-hand "0".
3. Set the range control to a position considerably higher than the voltage to be measured.
4. Connect the ground cable to the ground side of the voltage to be measured.

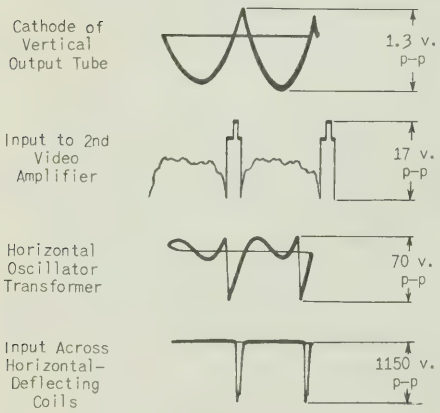


Figure 3. Typical television waveforms

5. Touch or connect the probe tip to the high side of the source voltage.
6. Reset the range control for a convenient deflection.
7. Read the ac voltage from the scale corresponding to the range control setting.

The meter scales of the WV-98A are calibrated in both rms and peak-to-peak voltages. Peak-to-peak voltage values are read from the red scales marked "P-P"; rms values of sine waves are read from the black scales marked "RMS".

NOTE: When it is desired to know which peak-to-peak scale is used, the indication is taken from the markings on the range-switch positions. Position 1, for example, is labeled "1.5V" and "4.0V". These figures correspond to the full-scale values of the corresponding rms and peak-to-peak scales. (Scales "F" and "K" in Figure 1.)

Examples of typical voltage waveforms found in television circuits are shown in Figure 3. Examples of other types of basic waveforms which can be measured by the WV-98A are shown in Figure 4.

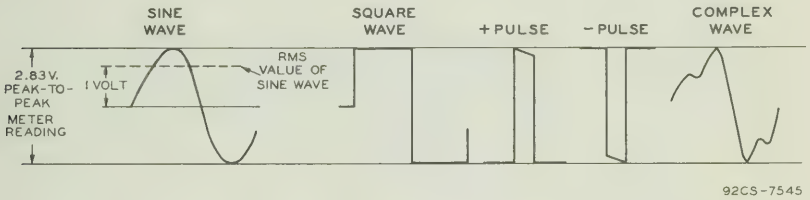


Figure 4. Typical voltage waveforms

The instrument has a maximum rated input for non-symmetrical waveforms of 2000 peak-to-peak volts. Sine waves and symmetrical complex waves up to 4200 peak-to-peak volts can be measured with somewhat reduced frequency response. (See Maximum Input Voltages and Footnote under "Specifications".)

Reliable ac voltmeter readings can be assured only if the characteristics of the voltmeter are compatible with the characteristics of the circuit under test. When the WV-98A is used to measured ac voltages, the "Specifications" on page 6 should be considered. Information on input resistance and capacitance, frequency response, and pulse response is given.

It should be remembered that when the instrument is connected to any voltage source it may cause a loading effect on the circuit and result in a reduced voltage at the test point. When the instrument is not used in accordance with the conditions given under "Specifications", the normal operating voltages of the circuit may change, resulting in an erroneous reading of normal operating voltages.

When any voltmeter is used to measure ac voltages, certain precautions in the interpretation of readings are necessary because connection of the meter to the

circuit may cause some disturbance. This is also true of the vacuum-tube voltmeter but its high input impedance minimizes such disturbances. The amount of circuit disturbance caused by the voltmeter is usually reflected in a decreased circuit voltage, the amount of decrease being dependent upon the characteristics of both the voltmeter and the test circuit.

For example, inaccurate readings of normal circuit conditions can be obtained from any one or a combination of the following conditions:

1. If measurements are made in high-impedance circuits, the instrument will cause loading of the circuit to a degree dependent upon the ratio of the circuit impedance to the voltmeter impedance. As this ratio increases, the loading effect of the voltmeter is increased with a corresponding change in the normal operating conditions of the circuit.

2. If the capacitance of the circuit is low in relation to the input capacitance of the voltmeter.

3. If the frequency of the source voltage is higher than the upper frequency rating of the voltmeter.

4. If the voltage waveform in the test circuit consists of narrow pulses with a low repetition rate.

The last of these four conditions needs careful consideration in order to interpret correctly the peak-to-peak readings of the Senior VoltOhmyst. The values of the circuit capacitors and resistors used in the peak-to-peak rectifier circuit of the WV-98A have been chosen to give a discharge time which will provide a reliable

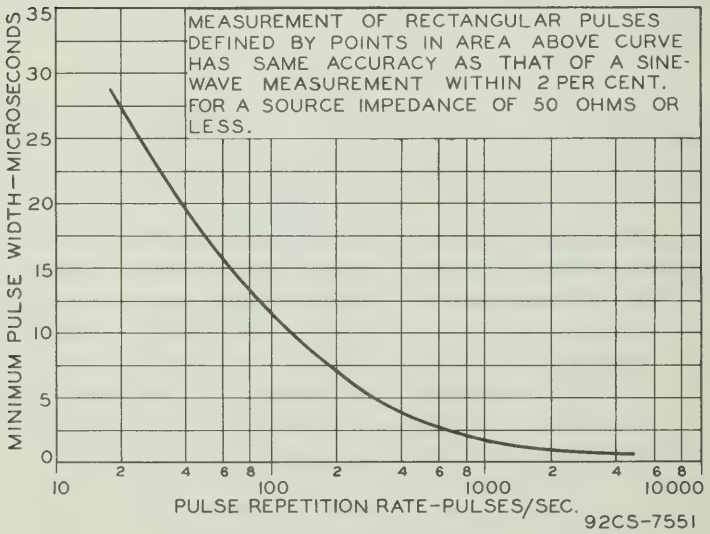


Figure 5. Pulse response capability of the WV-98A

peak-to-peak reading over its specified frequency range. If pulses of extremely short duration are applied to the rectifier circuit, the capacitors may not charge to the peak-voltage value of the pulse. If pulses with a low repetition rate are applied to the rectifier circuit, the capacitors will dissipate an appreciable part of the charge by the time the next pulse is applied. As a result, the capacitors are not charged to the full peak-to-peak value of the voltage. Therefore, both the rms and peak-to-peak voltage indications will be lower than the true value of the applied voltage.

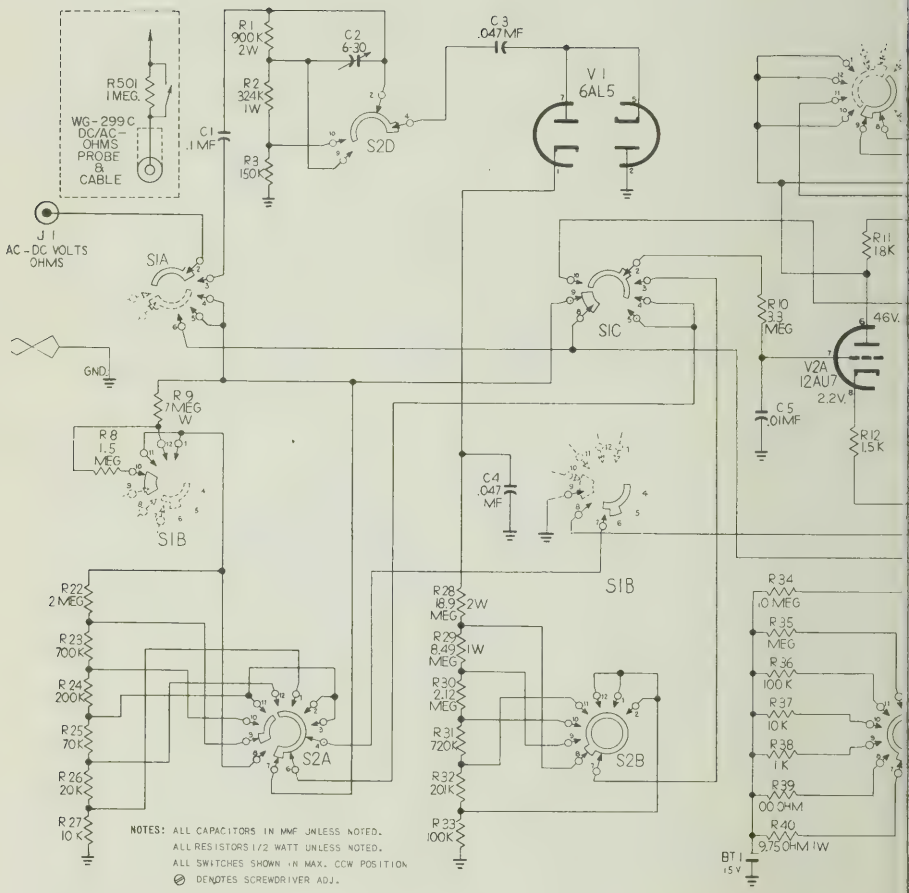
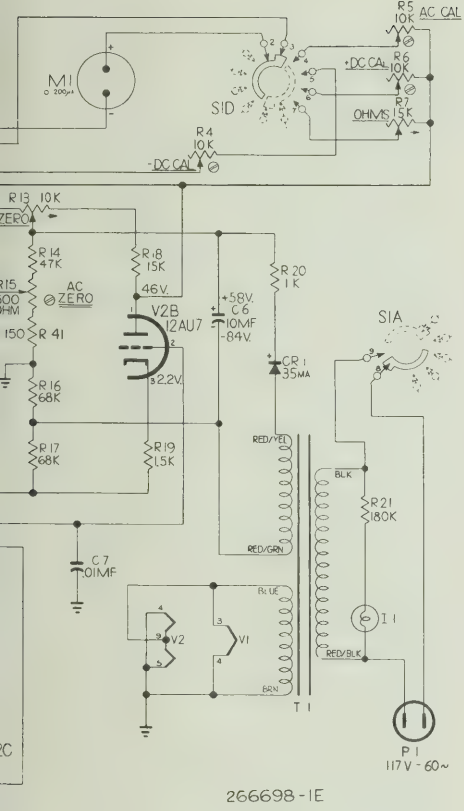


Figure 6. Schematic
For differences in switch wiring for instruments w



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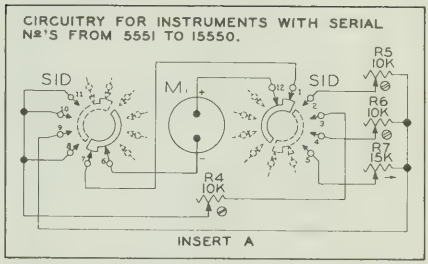

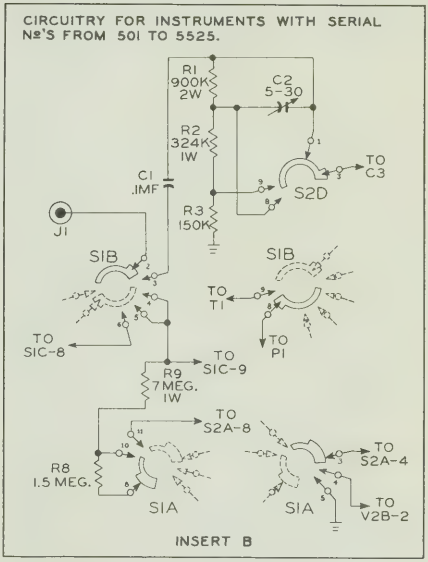

gram of the WV-98A.
serial numbers below 15600, see inserts A and B.

Replacement Parts List

WV-98A Senior VoltOhmyst

When ordering replacement parts, include the stock number and description of the part, as well as the serial number and code number of instrument. Parts should be ordered through a local RCA tube and parts distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1	Special tubular: 0.1 μf ±20%, 1000 volts	210098
C2	Trimmer: 6.0-30 μμf, 500 volts	210097
C3, C4	Paper, molded: 0.047 μf ±20%, 400 volts	73553
C5	Paper, molded: 0.01 μf ±20%, 400 volts	73561
C6	Electrolytic, dry: 10 μf-10% +100%, 150 volts	56234
C7	Same as C5	
CR1	Rectifier: selenium, 35 ma	210109
I1	Lamp: neon	48474
J1	Connector: chassis mounting type	210110
M1	Meter	210092-A
P1	Cord: power cord, 78″ long with plug	70392
	Resistors	
R1	Carbon film: 900,000 ohms ±1%, 2 watts	210103
R2	Carbon film: 324,000 ohms ±1%, 1 watt	210105
R3	Carbon film: 150,000 ohms ±1%, ½ watt	56483
R4, R5 R6	Variable: 10,000 ohms ±20%, ¼ watt	210099
R7	Variable: 15,000 ohms ±20%, ¼ watt	210100
R8	Composition: 1.5 meg ±5%, ½ watt	
R9	Carbon film: 7 meg ±1%, 1 watt	59538
R10	Composition: 3.3 meg ±10%, ½ watt	
R11	Composition: 18,000 ohms ±5%, ½ watt	
R12	Composition: 1500 ohms ±5%, ½ watt	
R13	Variable: 10,000 ohms ±10%, ¼ watt	210101
R14	Composition: 47,000 ohms ±5%, ½ watt	
R15	Variable: 500 ohms ±20%, ¼ watt	210102
R16 R17	Composition: 68,000 ohms ±5%, ½ watt	
R18	Composition: 15,000 ohms ±5%, ½ watt	
R19	Same as R12	
R20	Composition: 1000 ohms ±5%, ½ watt	
R21	Composition: 180,000 ohms ±10%, ½ watt	
R22	Carbon film: 2 meg ±1%, ½ watt	59540
R23	Carbon film: 700,000 ohms ±1%, ½ watt	59541
R24	Carbon film: 200,000 ohms ±1%, ½ watt	56733
R25	Carbon film: 70,000 ohms ±1%, ½ watt	59542
R26	Carbon film: 20,000 ohms ±1%, ½ watt	59177
R27	Carbon film: 10,000 ohms ±1%, ½ watt	55665
R28	Carbon film: 18.9 meg ±1%, 2 watts	210104
R29	Carbon film: 8.49 meg ±1%, 1 watt	94010
R30	Carbon film: 2.12 meg ±1%, ½ watt	94011
R31	Carbon film: 720,000 ohms ±1%, ½ watt	94012
R32	Carbon film: 201,000 ohms ±1%, ½ watt	94013
R33	Carbon film: 100,000 ohms ±1%, ½ watt	72893
R34	Composition: 10 meg ±5%, ½ watt	
R35	Composition: 1 meg ±5%, ½ watt	
R36	Composition: 100,000 ohms ±5%, ½ watt	
R37	Composition: 10,000 ohms ±5%, ½ watt	
R38	Same as R20	
R39	Composition: 100 ohms ±5%, ½ watt	
R40	Carbon film: 9.75 ohms ±1%, 1 watt	96613
R41	Composition: 150 ohms, ½ watt	
	Switches	
S1	Switch: rotary, wafer type, 5 positions, 2 sections, 8 circuits	212091-A
S2	Switch: rotary, wafer type, 7 position, 4 section, 5 circuit	210096
T1	Transformer: power, 117 v., 60 cps	210094
	Miscellaneous	
	Clip: alligator	35262
	Clip: alligator slide fit for 0.080 dia. probe tip terminal and must be slide fit for 0.080 dia. probe tip	210088
	Clip: battery	210108
	Ground Lead: includes alligator clip	48996

Symbol No.	Description	Stock No.
	Handle: case carrying handle, black	210093
	Insulator	204717
	Knob: control, blue	212148
	Knob: black rubber	94878
	Meter case: front, plastic	210287
	Socket: tube, 7 pin miniature	210106
	Socket: tube, 9 pin miniature	210107
	WG-299C DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing	212161
	Connector: internal, brass, for cable	210190-A
	Connector, cable: female, with set screw	203574
	Shell: front end, blue	210195-A
	Shell: middle section, with shield, bushing, and insulator	213664
	Shell: rear section, blue	210202-A
	Spring, coil: for front end	210197
	Spring, switch: with insulator	213665
	Tip, probe: with switch slide and 1-meg. resistor	212160
	Washer, tip	212163
	WG-299B DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing	212161
	Connector: internal, brass, for cable	210190-A
	Connector, cable: female, with set screw	203574
	Shell: front end, blue	210195
	Shell: middle section, with shield, bushing, and insulator	212159
	Shell: rear section, blue	210202-A
	Spring, coil: for front end	210197
	Spring, switch: with insulator	212162
	Tip, probe: with switch slide and 1-meg. resistor	212160
	Washer, tip	212163
	WG-299A DC/AC-Ohms Probe and Cable	
	Subassembly: consisting of: probe shell, shield, bushing and insulator, probe tip, switch, and 1-meg. resistor	211400
	Bushing: for probe tip	210196
	Shell: front molding	210195
	Shell: rear molding	210202
	Spring: for probe tip	210197
	Connector, cable: female	203574
	Connector, internal: for cable	210190

Special Applications

In addition to maintenance and service applications of the WV-98A in ac, dc, af, and pulsed electronic and electro-mechanical equipment, the instrument may be used with versatility in numerous special applications. The special applications described below will help to illustrate the wide range of usefulness of the instrument.

Oscillator Grid-Bias Measurement. The negative dc voltage developed at the grid of an oscillator tube is proportional to the amplitude of oscillation. The impedance of these circuits is usually high and any test instrument inserted into the oscillator must be of sufficiently high impedance so as not to change appreciably the total value of the circuit impedance. The WV-98A is well suited to measurements of this nature. To measure grid bias, the instrument should be set up on the appropriate dc-voltage range and the switch on the WG-299C Probe set to "DC".

Comparative voltage readings should be taken on each band of a multiband receiver and the main tuning capacitor should be rotated through each band while the bias is being measured.

AGC/AVC Voltage Measurements. The WV-98A can be used to measure agc or avc voltage at the diode-load resistor, along the bias buses, or at the grids of the controlled tubes.

Output Indication. The Senior VoltOhmyst is a useful instrument for measuring output in the alignment of radio and television receivers. In these applications, the switch on the WG-299C Probe is set to "DC" and the probe connected to the load resistor of the second detector in AM and TV receivers while the circuit components are adjusted for optimum output. In an FM receiver, the probe is connected to the limiter load resistor. The zero-center feature of the WV-98A is particularly useful in alignment of FM discriminators.

Bias-Cell Voltage Measurements. These small voltages can be measured accurately by the WV-98A. The expanded voltage scales 0 to 1.5 and 0 to 5 volts provide easy-to-read indications of small voltages, an important feature where bias voltages are critical.

Detection of Gassy Tubes. Gassy tubes frequently may pass the check of an ordinary tube tester but cause improper functioning of equipment in which they are installed. The presence of gas in an output tube or avc-control tube, for example, can impair the function of the entire receiver. In an RC-coupled circuit, the presence of a positive voltage at the grid of a tube usually indicates a gassy tube or a defective coupling capacitor. Check the socket grid-pin voltage with the tube removed. If no positive voltage is present, the tube is probably defective

Insulation-Resistance Measurements. Current leakage through the dielectric of capacitors and insulation of coils, transformers, cables, and other com-

ponents can be measured with the WV-98A in terms of resistance. Values of leakage resistance above 1000 megohms can be measured with the circuit shown in Figure 2.

When resistance measurements are made, the probe of the WV-98A is always positive with respect to the ground cable. This arrangement facilitates the measurement of leakage resistance in components such as electrolytic capacitors where polarity must be observed.

DBM Measurements. The graph on page 23 can be used to determine dbm values corresponding to rms ac-voltage values across a 600-ohm resistive load. A dbm value is defined as the number of decibels above or below a reference level of 1 milliwatt in 600 ohms at 1000 cycles. Zero dbm, therefore, would indicate a power level of 1 milliwatt; 10 dbm, 10 milliwatts; and 20 dbm, 100 milliwatts.

The graph makes possible rapid conversion of rms voltages to corresponding dbm values. Associated power levels can be read along the top of the graph. If the rms voltage is measured across a resistive load other than 600 ohms, the correction factors given below must be added algebraically to the dbm values read from the graph in Figure 7. For resistive loads not given in the table, the following formula should be used for determining the correction factor:

$$\text{Correction Factor} = 10 \log \frac{600}{R}$$

where R is the load in ohms. If R is greater than 600 ohms, the correction factor is negative.

Because dbm are defined with respect to a 600-ohm load, power levels correspond to voltage values. DBM can be measured in terms of rms voltages across a 600-ohm resistive load. For example, 0.775 rms volt indicates 0 dbm and 7.75 rms volts indicate 20 dbm. While these measurements must be made with a sine waveform to avoid waveform error, any frequency can be used which is within the range of the WV-98A. The decibel and ear-response curves have their closest correlation at 1000 cycles.

Resistive Load at 1000 cps	DBM*
600	0
500	+0.8
300	+3.0
250	+3.8
150	+6.0
50	+10.8
15	+16.0
8	+18.8
3.2	+22.7

*DBM is the increment to be added algebraically to the dbm value read from Figure 7.

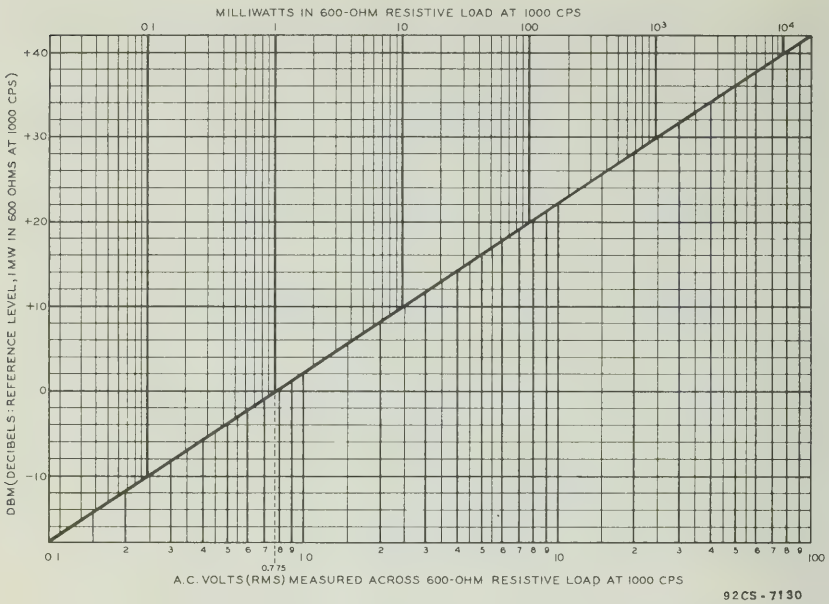

Figure 7. Graph for conversion of rms voltages to dbm values

Accessories

Available on Separate Order

When the WG-301A Crystal-Diode Probe is used with the Senior VoltOhmyst, the usable frequency range is extended to 250 megacycles. This probe consists of a germanium rectifier and an RC network in a polystyrene housing. The probe, which slips onto the front of the WG-299C Probe and Cable, eliminates the need for an extra cable.

The WG-301A may be used in rf circuits to measure sine-wave voltage values up to 20 rms volts in the presence of dc voltage as high as 250 volts. The over-all frequency range of the probe is from 50 Kc to 250 Mc. All rf voltages are read from the dc scales in terms of rms volts for sine waves. For example: A reading of 5 volts dc indicates that the sine wave being measured has an rms value of 5 volts. The all-over accuracy of the WV-98A when used with the WG-301A is $\pm 10\%$.

DC voltages as high as 50,000 volts can be measured directly by the WV-98A when the WG-289 High-Voltage Probe is used. The probe uses the WG-206 Multiplier Resistor, having a value of 1090 megohms, to present an over-all voltmeter input resistance of 1100 megohms. With a multiplying factor of 100, the Senior VoltOhmyst provides six full-scale positions of 150, 500, 1500, 5000, 15,000, and 50,000 volts. Do not measure voltages higher than 50,000 volts, because the maximum voltage rating of the probe may be exceeded. The extremely high

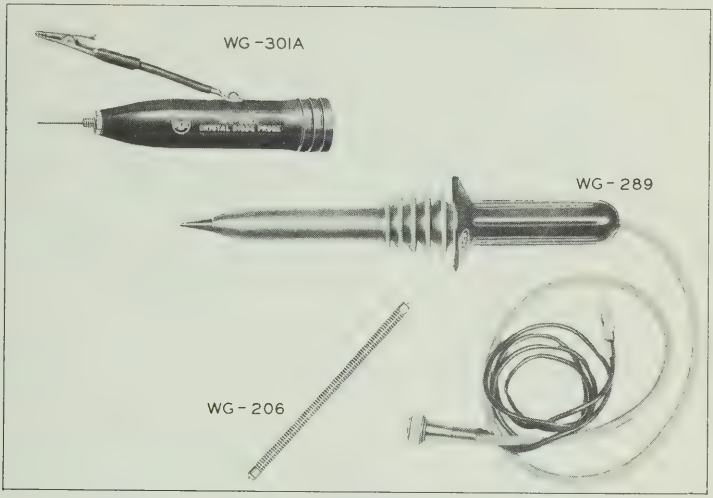

Figure 8. Accessories available on separate order

impedance of the WG-289 is especially desirable when it is necessary to measure voltages found in phototubes, Geiger-Counter tubes, television, and other high-impedance circuits which would not function properly if loaded down by a low-impedance voltmeter.

The WG-289 High-Voltage Probe offers distinct advantages in high-voltage circuits as well as low-voltage circuits characterized by high impedance or poor regulation.

Circuit Description

The operation of the Senior VoltOhmyst centers around a vacuum-tube bridge circuit using a 12AU7 twin-triode. (See schematic diagram, page 18.) When this bridge is properly balanced, the voltages at the two plates will be equal and the 200-microampere meter, connected between the plates, will read zero.

When a positive voltage is applied to the grid of triode section 1, the current through the left half of the bridge is increased, causing the voltage at the plate of this section to decrease. This current also flows through the common cathode resistor, increasing the voltage drop across it, and biasing the grid of triode section 2 in a negative direction. This causes a voltage increase at the plate of triode section 2. The difference in potential across the meter causes current to flow through the meter from the plate of section 2 to the plate of section 1.

When the WV-98A is used to measure ac voltage, the voltage is first rectified by an RCA-6AL5 twin-diode which serves as a full-wave peak-to-peak rectifier. This tube, shown as V 1 on the schematic diagram, has associated components chosen to give the circuit a long time constant. When the ac signal swings negative, C 3 is charged through the left-hand diode section to the negative peak value of the voltage. As the voltage starts in a positive direction, this diode section becomes nonconducting and the charge on C 3 is prevented from discharging. As the ac signal swings positive, the positive peak is added in series with the charge on C 3 and is applied to the plate of the right-hand diode section. C4 charges to a value equal to the sum of the positive and negative peaks. Because of the relatively long time constant of the circuit, the voltage across C 4 will be maintained at the peak-to-peak value of the applied ac voltage. A portion of this voltage is then applied as a dc voltage to the grid of triode section 1 of the 12AU7 bridge tube and the circuit action is the same as described above.

When the ac-signal rectifier is connected, however, contact potential within the tube causes a small amount of voltage to appear at the left-hand grid of the 12AU7, resulting in a slight unbalance of the bridge and a small meter deflection. To counteract this effect, a small voltage, taken from the AC ZERO control, is fed back to the grid of triode section 2 of the 12AU7. This voltage is used to correct for the contact potential of the ac-signal rectifier.

When the instrument is set up to measure resistance, ac voltage, or dc voltage, it is impossible for any voltage applied to the test probes to be applied directly to the meter itself. As shown in the schematic diagram, the meter is isolated from the source voltage by the 12AU7 bridge tube. This current limitation provided by the 12AU7 and its associated components decreases the danger of overloading the meter.

Maintenance

(See "Safety Precautions", page 4)

The WV-98A Senior VoltOhmyst is manufactured, tested, and calibrated under strict engineering supervision. If the instrument should require adjustment or repairs, the procedures outlined below should be followed.

The schematic diagram of the WV-98A is shown in Figure 6. Locations of calibration controls are shown in Figure 9. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. Replacement parts should be ordered from a local RCA tube and parts distributor and the code and serial numbers of the instrument, as well as the stock number of the replacement parts, should be specified in the order. Stock numbers and descriptions should be obtained from the Replacement Parts List on pages 20 and 21.

Mechanical Zero Adjustment:

The meter pointer should rest at the left-hand zero mark when the function selector is turned to the "OFF" position. If the pointer should come to rest at a deflected position, the position may be corrected mechanically as follows:

1. Remove the moisture-proof meter-adjustment plug.
2. Insert a scriber or similar tool to engage the zero-adjustment lever, and move the lever laterally as required to bring the pointer to "0".

CAUTION: Extreme care must be taken to prevent insertion of the tool to a depth which will injure the pointer spring. The meter warranty does not cover such damage.

3. Replace the meter-adjustment plug.

Anti-Static Solution:

The inside of the plastic meter case has been coated with a special anti-static solution to eliminate static effects on the action of the pointer. If the meter-pointer action becomes erratic, the condition of the coating may be checked by vigorously wiping the outside of the meter window with a clean, soft, dry cloth. If the anti-static coating has lost its effectiveness, the meter pointer will move off zero and remain there for several minutes. VoltOhmyst owners whose registration cards are on file at the RCA Camden, N. J. office may obtain a free 1-ounce bottle of coating by writing to RCA, Order Service, Building 60, Camden, N. J.

Electrical Balance Check:

1. Set the function selector to "+DC VOLTS" and allow the WV-98A to warm up for 15 minutes.
2. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 60% of full-scale deflection on any range.
3. Set the SELECTOR control to "—DC VOLTS".
4. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 10% of full-scale deflection on any range.

5. If the conditions given in steps 2 and 4 above cannot be satisfied, there is an unbalance between the two triode sections of the 12AU7 bridge tube and it should be replaced. See the section on Tube Replacement below.

Calibration

The calibration of the WV-98A should be checked after any internal adjustments are made or after any of the component parts are replaced. If recalibration is necessary, the instrument should first be recalibrated on dc voltage as follows:

NOTE: The accuracy of calibration cannot exceed the accuracy of the standards employed.

DC-Voltage Calibration:

1. Check the mechanical zero position of the pointer. If necessary, zero the pointer as described above.

2. Turn the function selector to "+VOLTS" and allow the WV-98A to warm up for at least 30 minutes.

3. Check the line voltage. The WV-98A should be calibrated at 117 volts, 60 cycles.

4. Rotate the ZERO ADJ control to bring the pointer exactly to zero. This control should not be readjusted during the rest of the calibrating procedure.

5. Set the range control at "50V".

6. Connect the Ground Cable clip to the negative terminal of a dc voltage source supplying exactly 50 volts. The switch on the WG-299C should be set to "DC". Connect the probe to the positive terminal of the source voltage.

7. With a screw driver, adjust the "+DC CAL" potentiometer R6 to bring the pointer exactly to the 50-volt mark on the scale. (See Figure 9 for location of calibration controls.)

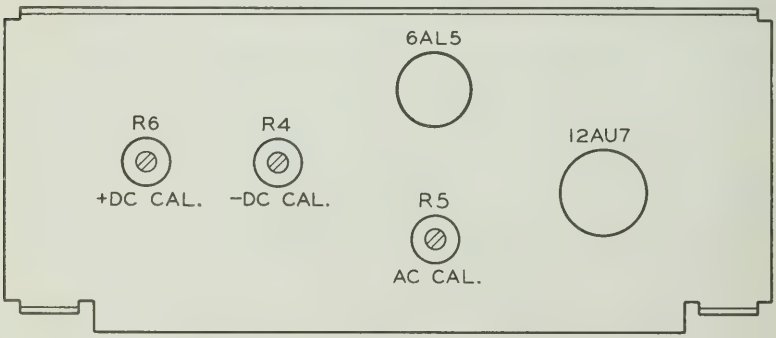

Figure 9. Locations of calibrating controls

8. Reverse the test lead connections at the voltage source.

9. Set the function selector to "—VOLTS".

10. With a screw driver, adjust the "—DC CAL" potentiometer R4 to bring the pointer exactly to the 50-volt mark on the scale.

11. Check the remaining dc-voltage ranges against other dc sources of known accuracy which provides full-scale deflection.

AC-Voltage Calibration:

To calibrate for ac voltage, proceed as follows:

1. Set the switch on the WG-299C to "AC-OHMS".
2. Set the function selector to "AC VOLTS".
3. Set the range selector to "1.5 VOLTS".
4. Short the WG-299C probe to the ground clip and adjust the AC ZERO potentiometer, R15 so that the pointer rests exactly at zero. If a zero meter reading cannot be obtained, replace the 6AL5. See "Tube Replacement", below.
5. Set the range control to "50V".
6. Apply 50 volts, 60 cps between the ground lead and the tip of the probe. The meter reading should be within ±3%. If the accuracy is not within this figure, adjust the AC CAL control, R5, (See Figure 9 for locations of calibrating controls) to give full scale deflection of the meter pointer.

AC Compensation Adjustment.

1. Set the switch on the WG-299C to "AC-OHMS".
2. Set the function selector to "AC VOLTS".
3. Set the range selector at the 500-volt range.
4. Set meter pointer at zero.
5. Set the range selector at the 150-volt range and apply an ac signal of 150 volts at a frequency of approximately 100 Kc to the test leads. With the 150-volt 100 Kc signal applied, adjust C2 with a screw driver for a reading of exactly 150 volts (C2 is located on the rear apron of the chassis).

Ohms Adjustment

NOTE: The battery must be installed for all resistance measurements.

1. Set the function selector to "+VOLTS" and make certain the pointer is at zero.
2. Turn the function selector to the "OHMS" position.
3. Set the range control to "RX1".
4. Adjust the OHMS ADJ control for full-scale deflection.
5. Turn the range switch to the "RXIMEG" position. The meter pointer should read above 1000 on the resistance scale. If the pointer indicates a lower value, there is excessive leakage in the ohmmeter circuit.

If it is necessary to readjust the OHMS ADJ control when changing from a low-range position to the "RXIMEG" position, refer to the section on TUBE REPLACEMENT below. If it is impossible to obtain full-scale setting of the pointer with the OHMS ADJ control and correct ac and dc voltage readings can be obtained, the battery should be replaced.

Tube Replacement

All tubes supplied originally with WV-98A have been thoroughly aged by operating them for several hours before installation in the instrument. This preliminary conditioning of a new tube helps to insure stability and dependable performance.

If a new tube is installed without prior aging, it may be necessary to rezero the instrument when it is switched from the lowest to the highest dc-voltage range. This operating inconvenience may be corrected by aging the tube as follows.

A suggested preaging method for the 12AU7 is to operate the plates at 115 volts dc with the grids and cathodes connected to the B— source. Heaters should be operated at 6.3 volts, 60 cps. The tube should be aged for approximately 12 hours before it is installed in the instrument. The calibration should then be checked.

An alternate, and usually satisfactory, aging procedure consists of operating the new tube in the WV-98A for approximately 36 hours, after which time the instrument may be recalibrated. If this procedure is unsatisfactory, the first aging procedure should be followed.

If it becomes necessary to replace the 6AL5, the tube can be aged for a minimum period of 36 hours by operating it in the instrument. After this period of time, the calibration should be checked according to the procedure outlined under "AC Calibration Check".

Battery Testing

CAUTION: Do not allow exhausted cells to remain inside the case of the WV-98A as chemicals from deteriorated cells may damage the instrument.

The battery should be tested frequently to insure accuracy of resistance measurements. It may be tested as follows.

1. Turn function selector to "OHMS".
2. Set range control to "RX1" position.
3. Rotate the OHMS ADJ control to bring the pointer to full-scale deflection.
4. Short the Ohms Cable to the Ground Cable for about 10 seconds.
5. Open the short circuit and observe the scale indication. Any appreciable deviation from full-scale deflection indicates weak cells which should be replaced.

RCA Repair Service

RCA maintains a complete repair service for the adjustment, calibration, and maintenance of RCA test equipment. If it becomes necessary to service this equipment, the report forms enclosed in this booklet should be filled out as described. It is important that:

1. Test equipment be packed carefully.
2. A full description of the trouble be included in the report.
3. All probes, cables, and test leads used with the equipment be included in the shipment.

Attention to these details will help prevent damage in transit and delay in repairs.

Test Equipment Service Report

If this instrument requires repair consult your authorized RCA Test Equipment Distributor who can direct you to a repair depot in your area; or write to:

Radio Corporation of America
Electron Tube Division
Test Equipment Section, Bldg. 60-1
Camden, New Jersey

If the instrument is in warranty, it will be repaired without cost.

Please fill out the following form in duplicate. Enclose the original with the instrument and keep the duplicate for your records.

To avoid delay in repairs:

1. Be sure to enclose all test leads and probes with instrument.
2. Pack carefully to avoid damage in shipment; test equipment is delicate.
3. Do *not* ship by parcel post. Use railway express or motor freight.

Date _____ 19____

Name of instrument _____ Type No. _____ Serial No. _____

Is instrument believed to be in warranty? ☐ Yes ☐ No

If, according to our records the instrument is out of warranty, please indicate your choice.

☐ Repair without quoting cost ☐ Quote cost before making repairs

Description of trouble:

What appears to be wrong? _____

_____

_____

Which controls do not work? _____

_____

Owner:

_____
Name

_____
Street

_____
City Zone State

THIS SPACE FOR DISTRIBUTORS ONLY:

☐ Ship instrument to distributor

☐ Ship instrument directly to owner

☐ Instrument is for stock ☐ Return in new carton

_____
Dist. Name

_____
Street

_____
City Zone State

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Test Equipment Service Report

If this instrument requires repair consult your authorized RCA Test Equipment Distributor who can direct you to a repair depot in your area; or write to:

Radio Corporation of America
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Date _____ 19____

Name of instrument _____ Type No. _____ Serial No. _____

Is instrument believed to be in warranty? ☐ Yes ☐ No

If, according to our records the instrument is out of warranty, please indicate your choice.

☐ Repair without quoting cost ☐ Quote cost before making repairs

Description of trouble:

What appears to be wrong? _____

_____

_____

Which controls do not work? _____

_____

Owner:

_____
Name

_____
Street

_____
City Zone State

THIS SPACE FOR DISTRIBUTORS ONLY:

☐ Ship instrument to distributor

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Dist. Name

_____
Street

_____
City Zone State

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Warranty

Radio Corporation of America warrants its test and measuring equipment, when properly registered, against defects in workmanship, materials, and construction under normal use and service for a period of one year from the date of original purchase. Under this warranty, our obligation is limited to repairing or replacing any defective parts.

This warranty does not apply to any instrument which has been tampered with in any way, or which has been misused or damaged by accident or negligence, or which has had the serial number removed, altered, or effaced.

RCA tubes and RCA batteries used in such equipment are covered by our standard tube or battery warranty.

Electron Tube Division
RADIO CORPORATION OF AMERICA
Harrison, New Jersey

This warranty is valid only when the card enclosed with the instrument is properly filled in and returned for registration.

RCA

SUGGESTED PRICE 50 CENTS
ISSUE 2

operating and
maintenance instructions

MASTER CHRO-BAR GENERATOR/SIGNALYST
Type WR-515A

RCA | Electronic Components | Harrison, N.J. 07029

Safety Precautions

Always become familiar with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below:

1. Always use an isolation transformer, such as the WP-25A Isotap, when working with AC/DC equipment having the chassis connected directly to one side of the AC power line. (Use the Isotap sockets marked "ISOLATED" for this purpose.)
2. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.
3. Filter capacitors may store a charge large enough to be lethal. Therefore, discharge filter capacitors before attaching test leads.
4. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.
5. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.
6. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in jeopardy of more serious risks, such as a bad fall or contact with a source of higher voltage.
7. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

Items Supplied with the WR-515A

- Shielded cable, with BNC connectors, WG-427A
- Direct/Isolation Adapter, WG-458A
- Matching Transformer, (75 to 300 Ohms) WG-451A
- Cable for gun-killer

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WR-515A 5/72
Printed in U.S.A.
2nd edition

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Description

The WR-515A Master Chro-Bar/Signalyst is the most advanced generator for television servicing ever developed by RCA. The many new features and functions of this unique instrument introduce entirely new concepts in color TV set-up and servicing procedures.

OUTPUT FOR ALL TEST SIGNALS IS PROVIDED NOT ONLY AT RF (CHANNEL 3*), BUT ALSO AT IF (45.75 MHz) AND VIDEO (4-5 MHz). This choice of output frequency provides servicing capabilities not possible with other generators. Now, you can use the output signals in stage-by-stage troubleshooting techniques, using the receiver screen to observe the effect of the patterns as they are processed by the various stages. By applying the signals at different points throughout the receiver, defective stages can often be isolated quickly. This method of troubleshooting can be particularly effective in servicing the new modular TV chassis.

Digital IC circuits are used in the WR-515A to provide solid, stable patterns over a temperature range of 75°F ± 70°, and a line voltage range of 120V ± 30V. There are no counter-alignment controls to require readjustment. All signals are derived from crystal-controlled oscillators.

The WR-515A provides the test signals required for adjusting convergence, color-phasing, gray-scale tracking, purity and linearity of color television receivers. Patterns include bars, dots, crosshatch, horizontal and vertical lines, and blank raster. The vertical and horizontal patterns can be selected in groups of three or ten lines. The output level of RF, IF, or video signals is adjustable. The vertical line and dot brightness is also adjustable.

The video output is low-impedance and will drive a 75-ohm video amplifier for closed-circuit TV system applications. A choice of positive or negative sync polarity is provided.

A new pattern called "SUPERPULSE" has been included in the WR-515A. This signal provides a white rectangle in the center of the screen. The SUPERPULSE has many applications, including adjusting gray-scale tracking (checks high-lights and low-lights simultaneously), and checking for

* The WR-515A can be operated on channel 4 by replacing the crystal as described on Page 14.

picture problems such as smearing, ringing, and video peaking. For troubleshooting applications, you can inject the SUPERPULSE signal at the RF, IF, or video test points, then with an oscilloscope, trace the waveforms through the receiver to locate the defective stage.

The color bar pattern provides ten bars simultaneously, including R-Y, B-Y, -(R-Y) I and Q signals, spaced at 30 degree phase intervals. This pattern is for use in checking color phase and matrixing circuits, and adjusting automatic frequency phase control (AFPC). Narrow brightness pulses are added at the edges of each color bar to aid in checking the "fit" or registration of the brightness and color signals. The color bar pattern is generated in a manner that establishes the background area between the bars at a luminance level approximately mid-way between black (no luminance) and full luminance (white). This permits AFPC alignment checks without using an oscilloscope.

A special color bar "mark" function places a brightness line on the 3rd, 6th and 9th (red, blue, and blue-green) bars. This feature provides positive identification of the bars, eliminating confusion that can arise if a bar is "missing" due to overscan, or if the colors are out of sequence due to AFPC misalignment.

The dot pattern provided by the WR-515A is used primarily in convergence adjustment. The pre-shoot and over-shoot area (small black edging preceding and following each dot) can be used to estimate the overall quality of the receiver alignment.

The crosshatch, vertical line, and horizontal line patterns are for use in adjusting linearity, overscan, and pincushion effect in both black and white and color receivers, and as an alternate pattern for adjusting convergence. The line and dot patterns can be selected in combinations of three or ten. The blank raster function provides a smooth, noise-free white raster as required for adjusting purity.

Color-coded pushbutton switches are included to short out the picture tube control grids as required in convergence and purity adjustments. A removable cable with special piercing clips is provided for connection to the grid leads of the picture tube guns. The Master Chro-Bar Generator operates from a standard 120-volt, 60 Hz power line. Accessories supplies includes the gun-killer cable, a shielded output cable, a 75-to-300-ohm matching transformer unit, and a direct/isolated output unit. A bracket is located on the rear of the instrument for convenient storage of the test leads.

Adjustment or Procedure	Recommended WR-515A Pattern
AGC	Lines; 10V, 11H
Video Peaking	Superpulse
H and V Centering	Lines; 3V, 3H
Purity	Blank Raster
Overscan	Lines; 3V, 3H
Linearity	Lines; 10V, 11H
Pincushion	Lines; 11H
Gray Scale Tracking	Superpulse
Convergence	
Static	Dot, Lines (3V, 3H) or Superpulse
Dynamic	Lines; 10V, 11H
AFPC (Tint)	Color Bars with "mark".
Troubleshooting	
Signal Injection	Superpulse, Color Bars, Lines
Signal Tracing	Superpulse, Color Bars

Specifications

Note: All signals are crystal-controlled.

RF OUTPUT

Frequency ..... Picture carrier 61.25 MHz. (Ch. 3)*
Impedance ..... 75 Ohms or 300 Ohms
Level ..... Adjustable up to 50 Millivolts (Across 300 Ohms)

IF OUTPUT

Frequency ..... 45.75 MHz
Impedance ..... 75 Ohms
Level ..... Adjustable up to 50 Millivolts

VIDEO OUTPUT

Frequency ..... 4-5 MHz
Impedance ..... 75 Ohms
Level ..... Adjustable up to 2 Volts (Across 75 Ohms)
Sync Polarity ..... Choice of Positive (+) or Negative (—)

TEST PATTERNS

Color Bars ..... Ten bars, spaced at 30° phase intervals. Includes R-Y, B-Y, -(R-Y), I, and Q signals. (Variable Chroma Level)

Dots .....
Crosshatch (H & V) ..... } Select pattern with 3 or 10 H & V lines.** V line and dot brightness is adjustable with panel control.
Horizontal Lines ..... }
Vertical Lines .....

Blank Raster ..... White, no-noise raster (Sync Modulation Only).
Superpulse ..... White rectangle centered on blank screen. For receiver adjustment and troubleshooting.

OTHER SIGNALS

Color Bar Mark ..... Identifying brightness line on leading edge of 3rd, 6th and 9th color bars (red, blue, and bluish-green).

POWER REQUIREMENTS ..... 120 V ± 30 Volts, 60 Hz., 5 Watts

TEMPERATURE RANGE ..... 75°F ± 70°

DIMENSIONS

Width ..... 10 Inches (15 cm)
Height ..... 4 Inches (10 cm)
Depth ..... 8 Inches (20 cm)

WEIGHT ..... Approximately 6 lbs. (2.7 Kg)

---

* The WR-515A can be operated on channel 4 by replacing the crystal as on page 14.

** The number of H lines generated is actually 11. On most receivers with normal overscan, only 10 will be seen.

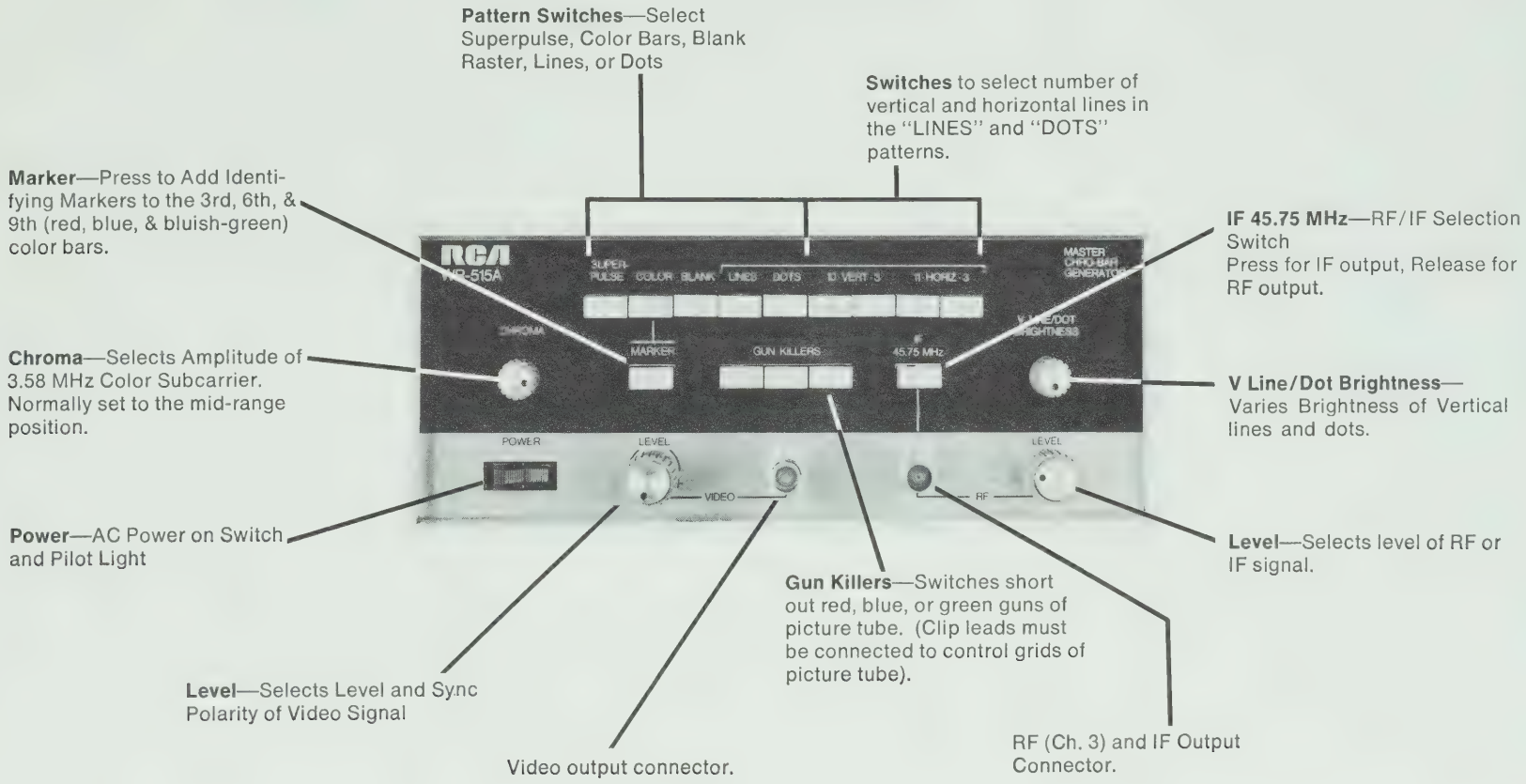

Pattern Switches—Select Superpulse, Color Bars, Blank Raster, Lines, or Dots
Switches to select number of vertical and horizontal lines in the "LINES" and "DOTS" patterns.
Marker—Press to Add Identifying Markers to the 3rd, 6th, & 9th (red, blue, & bluish-green) color bars.
IF 45.75 MHz—RF/IF Selection Switch
Press for IF output, Release for RF output.
Chroma—Selects Amplitude of 3.58 MHz Color Subcarrier. Normally set to the mid-range position.
V Line/Dot Brightness—Varies Brightness of Vertical lines and dots.
Power—AC Power on Switch and Pilot Light
Level—Selects level of RF or IF signal.
Gun Killers—Switches short out red, blue, or green guns of picture tube. (Clip leads must be connected to control grids of picture tube).
Level—Selects Level and Sync Polarity of Video Signal
Video output connector.
RF (Ch. 3) and IF Output Connector.
RCA
WR-515A
SUPER-PULSE
COLOR
BLANK
LINES
DOTS
10 VERT · 3
11 HORZ · 3
MASTER CHROMA GENERATOR
CHROMA
MARKER
GUN KILLERS
45.75 MHz
V LINE/DOT BRIGHTNESS
POWER
LEVEL
VIDEO
RF
LEVEL

Figure 1. WR-515A panel controls.

Operation

General

The following procedure describes the connections of the WR-515A to a TV receiver, and the method of obtaining the desired patterns on the receiver screen. For more detailed information for adjusting purity, linearity, convergence, etc., and for troubleshooting techniques, refer to the applications information supplied with the instrument.

Before using the generator with a particular TV receiver, check the operation of the receiver by observing the reception of a televised station signal. Adjust the receiver horizontal and vertical hold controls so that the picture is locked in properly, then set these controls to the center of their holding range. Switch out any special receiver controls such as AFT (automatic fine tuning) or automatic tint control.

Plug the generator power cord into a 120 volt, 60 Hz AC line, and turn on the instrument with the POWER switch.

Vertical-Retrace Lines

A few vertical retrace lines may appear in the upper section of the pattern generated by the WR-515A. This condition is normal, and does not affect the use of the instrument. These retrace lines will vary with TV receivers, and can be regulated to a certain extent by adjusting the receiver "vertical hold" control.

Hookup Procedure

RF SIGNAL INJECTION

1. Connect the WG-451A Matching Transformer to the WG-427A cable, and attach the cable to the RF output connector. Set the RF LEVEL control to mid-range. Be sure the "IF" pushbutton is released in the "OUT" position.

   Note: If the receiver has a direct 75-ohm input, the WG-427A can be connected directly to the input without using the WG-451A matching transformer. It may be necessary to use a special adapter BNC female to type "F" male adapter, (not supplied).
2. Disconnect the antenna from the receiver. Attach the WG-451A leads to the antenna terminals.
3. Set the receiver to Channel 3. Select the desired pattern, and adjust the receiver fine-tuning and other controls for the best picture.

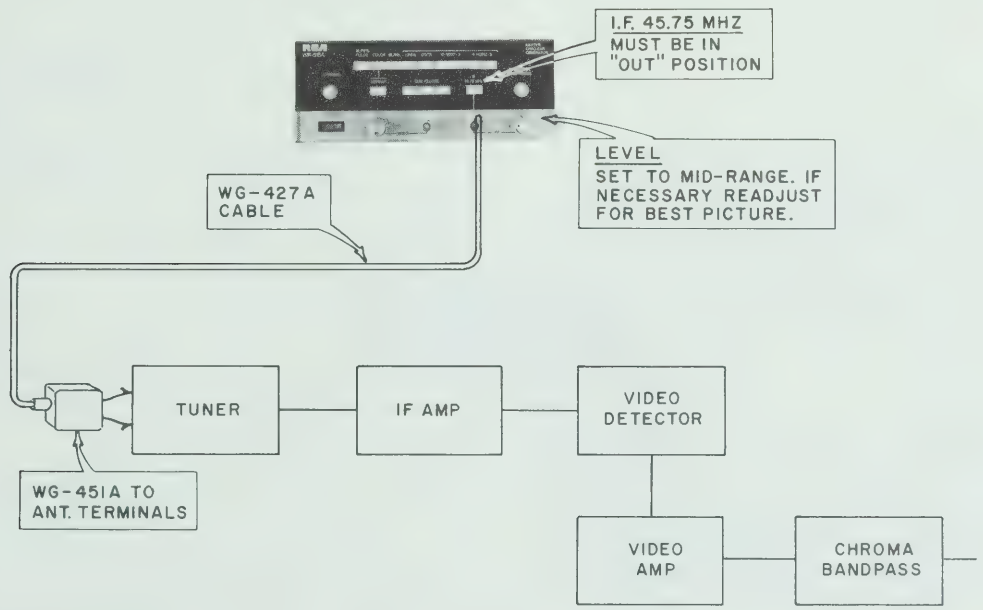


Figure 2. Hookup for RF signal injection.

IF SIGNAL INJECTION

1. Connect the WG-458A Direct Unit to the WG-427A cable, and attach the cable to the RF output connector. Press the IF 45.75 MHz pushbutton, and set the LEVEL control to mid-range.
2. Set the tuner to an unused channel, preferably on UHF. There should be no antenna connected to the receiver.
3. Connect the WG-458A adapter to the mixer input test point or other suitable test point in the IF amplifier. In some sets, the cable from the tuner to the IF stage can be unplugged. If so, the IF signal can conveniently be applied to this cable. This technique also has the advantage of completely isolating the IF stage from the tuner.
4. Adjust the generator controls to provide the desired pattern. Adjust the generator RF/IF LEVEL control and the receiver brightness and contrast controls for the best picture. If the signal is injected at other test points in the IF stage, it will usually be necessary to readjust the generator LEVEL control.

VIDEO SIGNAL INJECTION

1. Connect the WG-458A Direct Unit to the WG-427A cable, and connect the cable to the VIDEO output connector.
2. Set the receiver tuner to an unused channel, preferably on UHF. There should be no antenna connected to the receiver. In some sets, the cable from the tuner to the IF stage can be unplugged, further isolating the tuner from the rest of the receiver.
3. Connect the WG-458A to the input of the video stage (video detector output), or other suitable test point in the video or chroma stages.

   To protect the generator from damage when connecting the video output to a circuit having high B+ voltage, it is important that the yellow adapter lead be used. Use the red lead only when higher signal level is required, and when the test point has *less than 35 volts DC.* Connect the black lead to ground for all applications.

   FUSE PROTECTION—An internal fuse is installed in series with the video output connector. If B+ voltage above 35 volts is inadvertently connected to the red lead of the WG-458A, this fuse may burn out, resulting in loss of video output signal. Replace the fuse with the same type (GJV, 1/8 ampere). The fuse is accessible by removing the lower half of the case as described on page 14.
4. Turn on the receiver. Select the desired generator pattern, and set the VIDEO LEVEL control to "+" (clockwise) or "—" (counterclockwise) as required to produce a good picture on the screen. If the control is turned to the wrong polarity, the picture will be dark and there will be no sync. Turn the control in the proper direction until the picture begins to "tear," then back off the control just to the point where a good picture is obtained.
5. If the signal is applied to other test points in the video amplifier, it will be necessary to readjust the video level/polarity control. The video sync polarity may be inverted (reversed) at each stage of the amplifier.

   Caution: Always discharge (or ground) the WG-430A leads together when changing from one video test point to another. This is especially important when going immediately from a test point with B+ voltage to a vulnerable circuit point such as the input of a solid-state device. The generator video output is designed to discharge itself in about fifteen or twenty seconds, however.

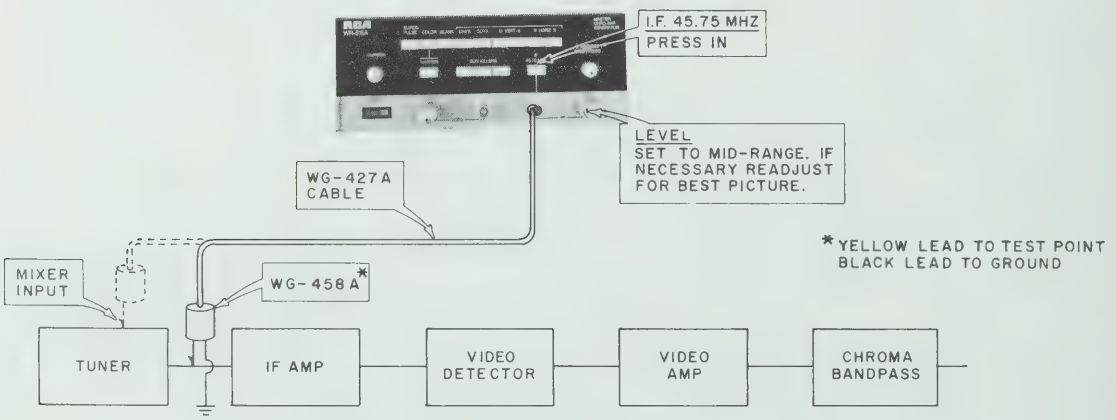


Figure 3. Hookup for IF signal injection.

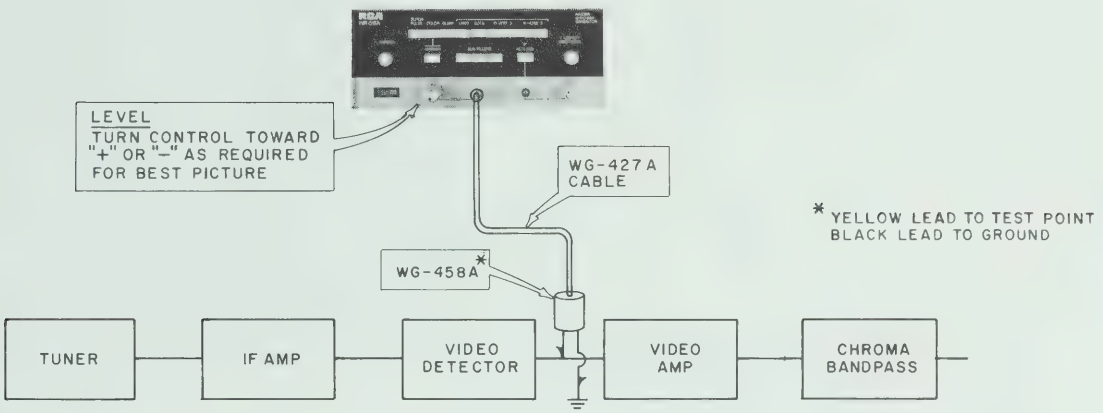


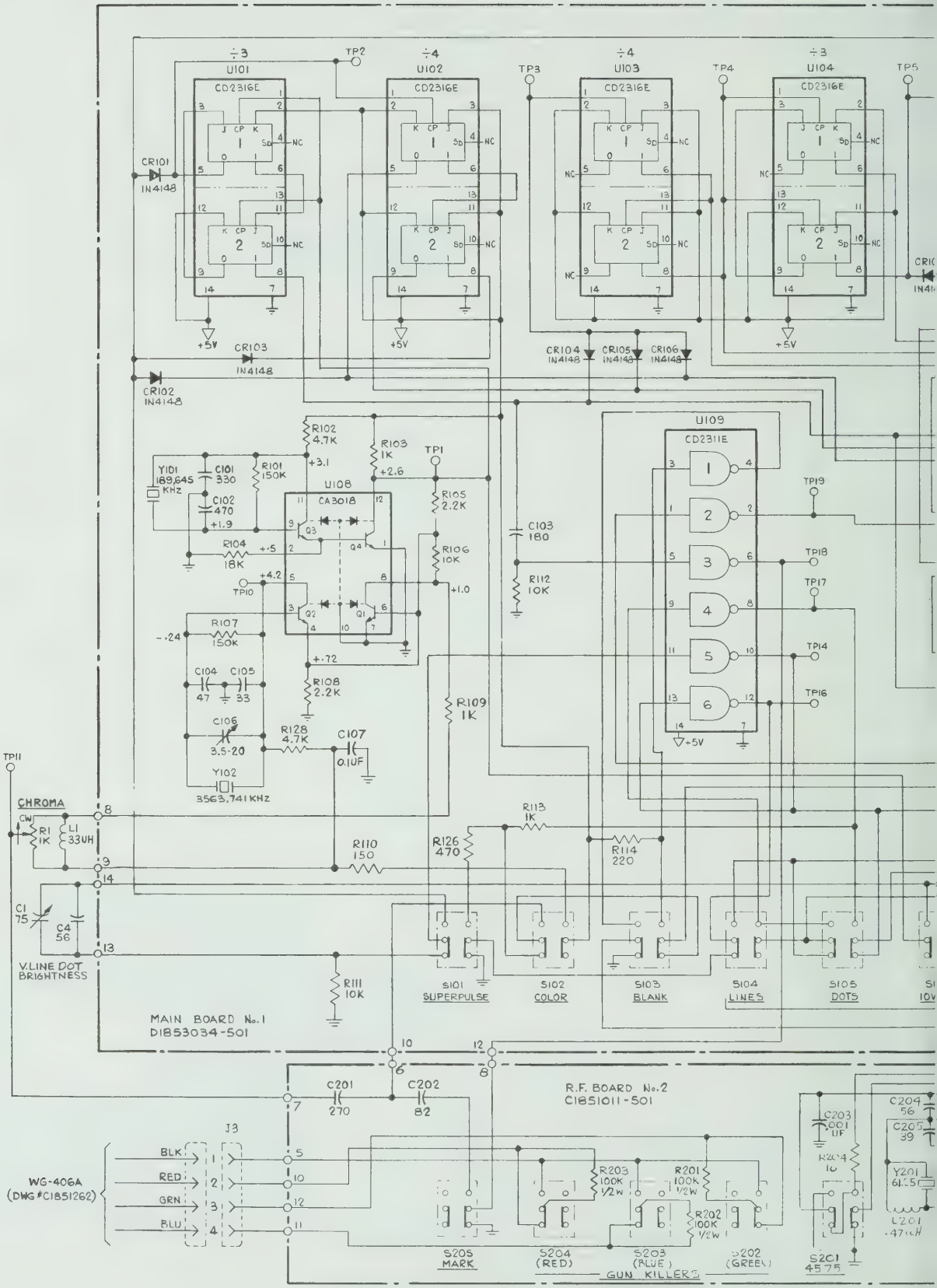
Figure 4. Hookup for video signal injection.

Pattern Selection

To select the desired pattern, just press the appropriate pushbutton; SUPERPULSE, COLOR (for color bars); BLANK (blank raster); LINES (for horizontal lines, vertical lines, or a crosshatch combination) or DOTS.

SUPERPULSE. The Superpulse pattern provides a white rectangular area in the center of the screen, similar to Figure 5. This pattern is useful for adjusting "gray-scale tracking," for evaluating general receiver performance, including purity, smear, ringing, and video peaking adjustment and as an alternate pattern for adjusting static convergence. For troubleshooting using a signal tracing technique, the Superpulse pattern is especially useful since it provides a simple, sharply defined oscilloscope waveform. Distortion or loss of gain in the pattern will be readily apparent.

Figure 5. Superpulse pattern.


÷3
U101
CD2316E
TP2
÷4
U102
CD2316E
TP3
÷4
U103
CD2316E
TP4
÷3
U104
CD2316E
TP5
CR101
IN4148
+5V
CR103
IN4148
CR102
IN4148
CR104
IN4148
CR105
IN4148
CR106
IN4148
U109
CD2311E
TP19
TP18
TP17
TP14
TP16
R102
4.7K
R103
1K
TP1
Y101
189.645
KHz
C101
330
R101
150K
U108
CA3018
C102
470
R104
18K
R105
2.2K
R106
10K
C103
180
R112
10K
TP10
R107
150K
C104
47
C105
33
C106
3.5-20
R108
2.2K
R109
1K
R128
4.7K
C107
0.1UF
Y102
3563.741 KHz
TP11
CHROMA
R1
1K
L1
33UH
R110
150
R126
470
R113
1K
R114
220
C1
75
C4
56
V.LINE DOT
BRIGHTNESS
R111
10K
S101
SUPERPULSE
S102
COLOR
S103
BLANK
S104
LINES
S105
DOTS
MAIN BOARD No.1
D1853034-501
C201
270
C202
82
R.F. BOARD No.2
C1851011-501
J3
WG-406A
(DWG#C1851262)
BLK
RED
GRN
BLU
R203
100K
1/2W
R201
100K
1/2W
R202
100K
1/2W
C203
.001
UF
R204
10
C204
56
C205
39
Y201
61.25
L201
.47uH
S205
MARK
S204
(RED)
S203
(BLUE)
S202
(GREEN)
GUN KILLERS
S201
4575

COLOR BARS. The color bar pattern consists of ten color bars as shown in Figure 7. All ten bars may not always be entirely visible depending on the adjustment of the receiver horizontal centering and width adjustment. Set the receiver "color" control and the generator CHROMA control to mid-range.

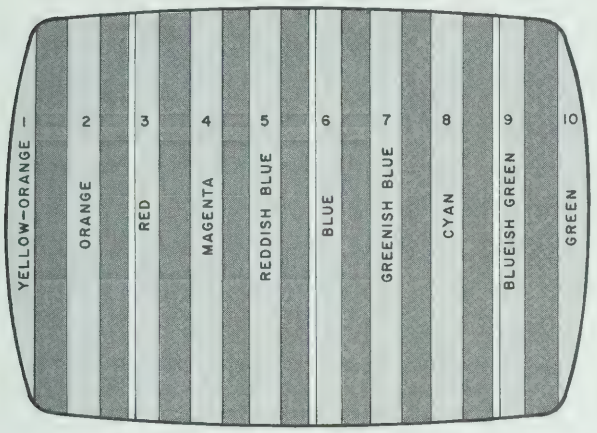


Figure 7. Color bar pattern, with bar marks on 3rd, 6th, and 9th bars.

Switch off any controls such as "Accutint" that restrict adjustment of tint. Adjust the receiver tint control so that the color bars appear as shown in Figure 7. The bars can be identified easily by pressing the MARK pushbutton. This will place a bright line on the 3rd, 6th, and 9th (red, blue, and blue-green) color bars. Readjust the generator CHROMA control to the minimum position that provides suitable color level.

BLANK RASTER. The blank raster pattern applies only sync modulation to the RF carrier, so that a white raster without "snow" is provided. The blank raster is especially designed for use in purity adjustments.

LINES AND DOTS. On the lines or dots function, you have a choice of 10 or 3 vertical and 11 or 3 horizontal lines (or rows of dots). *Note:* Although 11 horizontal lines are generated, on most receivers with normal overscan only 9 or 10 will be seen. To obtain horizontal or vertical lines alone, simply release both the 10 (11 for HORIZ) and the 3 pushbuttons for the other function. The brightness (or width) of the vertical lines or dots can be varied with the V LINE/DOT BRIGHTNESS control. Applications for the lines and dots functions include convergence, linearity, and overscan adjustments.

Note: If the vertical lines or vertical rows of dots do not appear, readjust the V LINE/DOT BRIGHTNESS control.

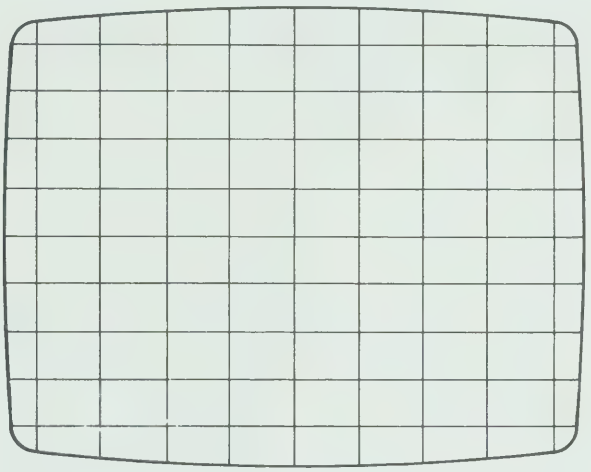


Figure 8. Line pattern showing horizontal and vertical lines. There are 11 horizontal and 10 vertical lines generated. Of these, only 9 or 10 lines will be seen with normal overscan adjustment.

A complete crosshatch pattern formed by all 10 vertical and horizontal lines is shown in Figure 8.

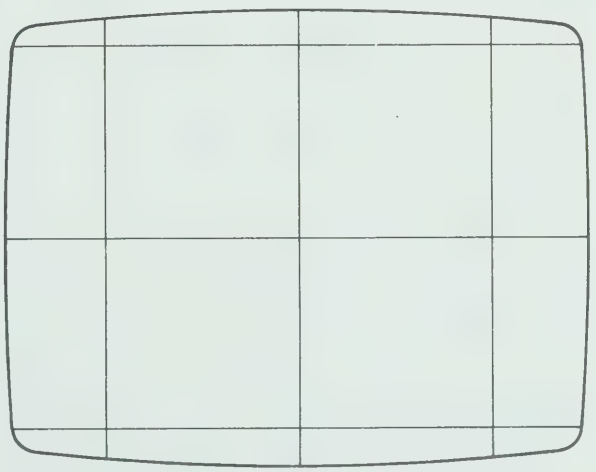


Figure 9. Line pattern with 3 horizontal and 3 vertical lines.

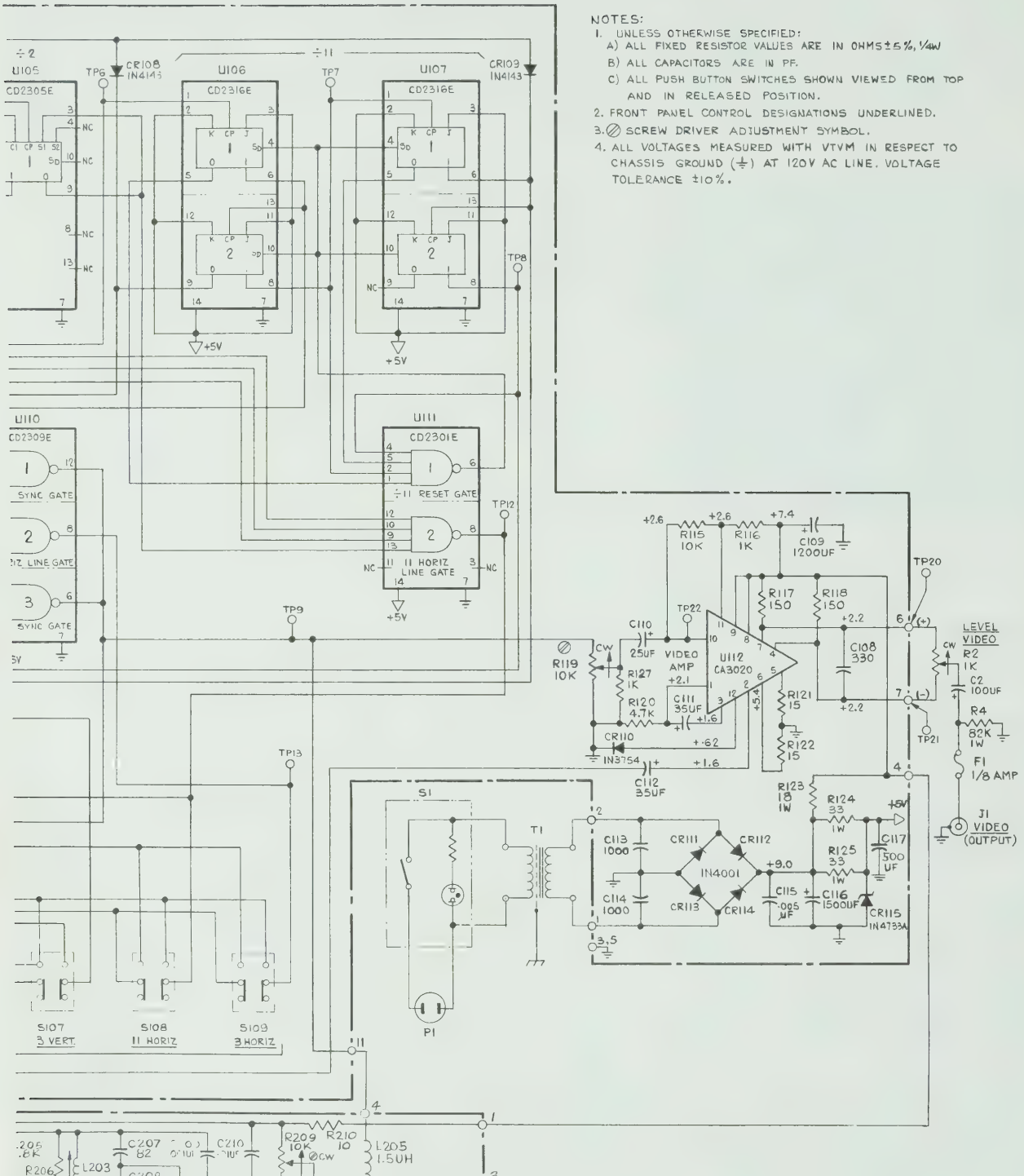


Figure 6. WR-515A *schematic diagram.*

Gun-Killer Switches

Three switches are provided on the panel of the WR-515A for shorting out the color guns as required in convergence adjustment.

Procedure:

1. Turn off power to TV receiver. Plug the gun-killer switch cable into the receptacle on the rear panel of the Chro-Bar.
2. Connect the red, blue, and green leads from the cable to the corresponding grid-leads of the picture tube socket. It is not necessary to remove the socket from the color picture tube or make any direct connection to the socket pins. The special alligator clips will pierce the insulation on the grid lead and make contact with the wire. Position the lead in the clip so that the point of the piercing pin is centered over the wire, then force the jaws of the clip together.
3. Connect the black lead clip to the chassis ground of the receiver.
4. Turn on the TV receiver. Set the red, blue, or green gun switch to the "OFF" position to short out the corresponding color gun or guns. Return the switches to the "ON" position for normal operation of the color picture tube.

Circuit Description

The WR-515A Master Chro-Bar is a completely solid-state generator, providing color bars, dots, blank raster, V lines, H lines, crosshatch, and a new signal called "Superpulse." The instrument utilizes eleven digital IC's, and two IC transistor arrays. All signals produced by the generator are crystal controlled.

A 264 single-scan system is used rather than the 525-line interlace system. The 264-line raster has the advantage of providing small dots and single horizontal line registration with no flicker. The following output signals are developed in the generator:

Signal Frequency	*Function*
15804 Hz	H Sync
60 Hz	V Sync
61.25 MHz	Picture Carrier (Ch. 3)
3563.741 kHz	Color Off-Set Frequency
189.6 kHz	Vertical Lines (10)
47.4 Hz	Vertical Lines (3)
659 Hz	Horizontal Lines (10)
180 Hz	Horizontal Lines (3)
45.75 MHz	IF Output
4-5 MHz	Video Output
63 kHz	Bar Mark

A series of 13 flip-flop circuits are used to make a countdown from 189.6 KHz to 60 Hz. Starting with the 189.6 MHz master oscillator, four flip-flop circuits (U101 and U102) divide the signal by 12 to provide signals for the 3 and 10 vertical line patterns and horizontal sync.

The next division is by 24 (U103, U104, and U105), developing the horizontal line signals. The final count, divides the frequency by eleven (U106 and U107). It is the final count that provides the three horizontal-line signal and vertical sync.

Many of the intermediate frequencies provided by the countdown circuitry are used in the processing (gating) other signals.

The "gated-rainbow" color bar pattern is developed from the 3563.741 kHz oscillator (crystal Y102 and sections of U108). This frequency is off-set from the standard color subcarrier signal by 15,804 kHz, the horizontal frame frequency. As a result, a phase difference of 360 degrees occurs with each frame, producing a "rainbow" of color across the picture tube screen. This signal is used as a keyer to gate the signal at a 189 kHz rate, producing 12 color bars at 30 degree phase intervals. Two of the bars are eliminated during the sync interval. The color bar signal output is fed through the CHROMA LEVEL control, R1.

In the blank raster function, the function switch disables the vertical and horizontal signals so that only sync modulation is present.

All pattern signals are available at RF, IF, or video frequencies. For direct video output, the pattern signals are applied to an integrated circuit power amplifier (U112) used to provide power gain for the direct video output signal. This signal source can be used to drive low impedance video lines.

For RF or IF, the pattern or signal is applied to the CR201 modulator circuit. With the 45.75 MHz IF switch (S201) pressed, the 45.75 MHz circuit formed by crystal Y202 and ICU201 provide an IF carrier. With S201 released, the 61.25 MHz (Ch. 3) circuit formed by crystal Y201 and the other section of ICU201 provide an RF carrier.

Maintenance

General

The performance of the RCA CHRO-BAR Generator depends on the quality of the components. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. When ordering replacement parts, refer to the Parts List on page 17. The schematic diagram for the instrument is on pages 10 and 11. Further aids to servicing include the Circuit Description, page 13 and Figures 10 and 11, showing the location of components on the circuit board. The generator can be removed from the case by taking out the two screws on each side and four screws on the bottom.

RCA Repair Service

Authorized RCA Test Equipment Service Depots are available for repair and calibration of this equipment. For the name of the depot nearest you, contact your RCA Test Equipment distributor, or write to RCA Electronic Instruments, 415 South Fifth Street, Harrison, New Jersey 07029.

Fuse Replacement

An internal fuse is installed in series with the video output connector. If B+ voltage above 35 volts is inadvertently connected to the red lead of the WG-458A unit, this fuse may burn out, resulting in loss of video output signal. Replace the fuse with the same type (GJV, 1/8 ampere, RCA Stock No. 423730, or equiv.). The fuse is accessible by removing the lower half of the case as described below.

Removing the Case

To remove the case for servicing, take out the two screws on each side of the unit, loosen the handle knobs, and lift off the upper and lower case halves.

Operation on Channel 4

The unit is provided with a 61.25 MHz channel 3 crystal. In some areas however, the local channel station signal may be so strong that it causes interference with the generator pattern. In this situation, it is recommended that the crystal be replaced with a channel 4 crystal. The stock number for the crystal is 243333. Order from your local RCA Parts and Accessories Distributor. It will be necessary to readjust the RF oscillator as indicated below.

RF Oscillator Adjustment

The picture-carrier oscillator should require adjustment only if the crystal or component parts are changed.

1. Connect the WR-515A output cable to the antenna terminals of the receiver. Set the receiver to the same channel as the crystal in the RF oscillator of the generator.
2. Press the LINES switch, and the 10 VERT and 10 HORIZ switches to obtain a full crosshatch pattern. Adjust coil L202 slightly as necessary to obtain a crosshatch pattern on the TV receiver.
3. Turn the generator POWER switch on and off several times. The crosshatch pattern should lock in each time.

Modulation Level Adjustment

1. Connect the instrument to a TV receiver. Set the function switch to the DOTS position and obtain a crosshatch pattern on the receiver screen. Adjust the receiver brightness control so that there is no background brightness and only the dots are visible.
2. Using a small screwdriver, adjust the modulation level control, R209, (located near the center of the circuit board, near the large capacitor, C11) fully counterclockwise so that the background area of the pattern turns black.
3. Turn the control clockwise to the point where the dots "wash out" and cannot be seen, then counterclockwise just to the point where the dots appear.

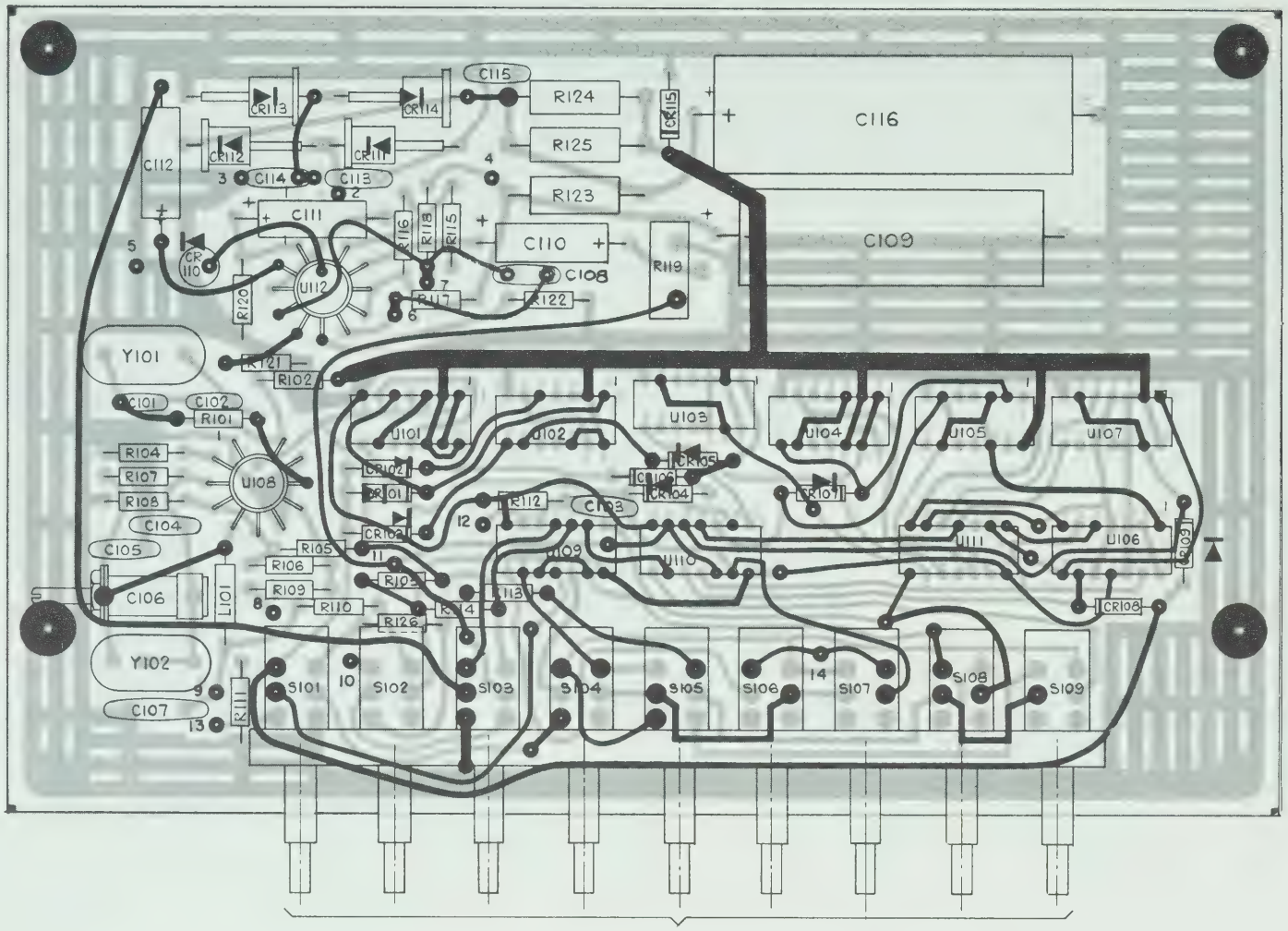


Figure 10. Component location on the main printed circuit board. View from the component side.

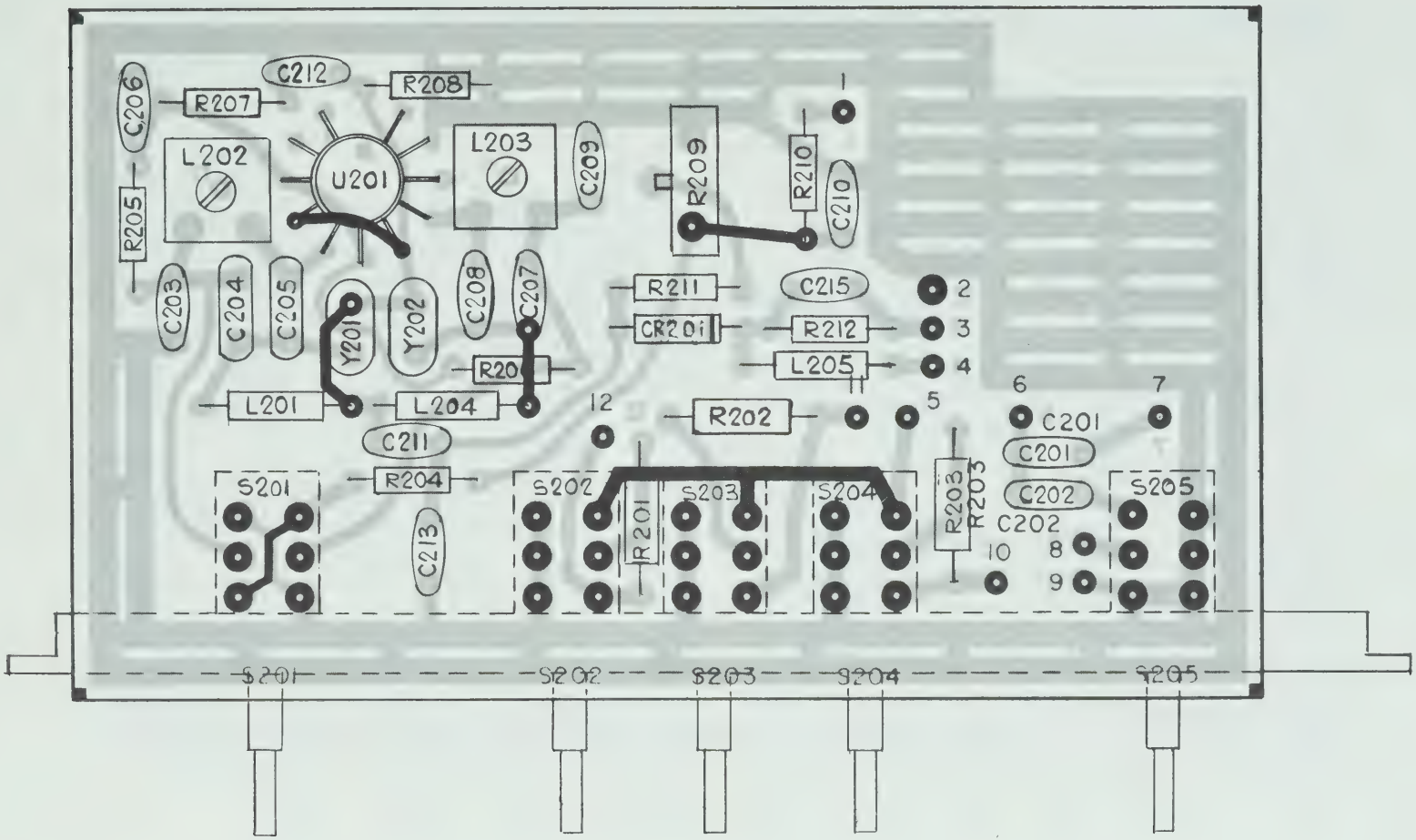


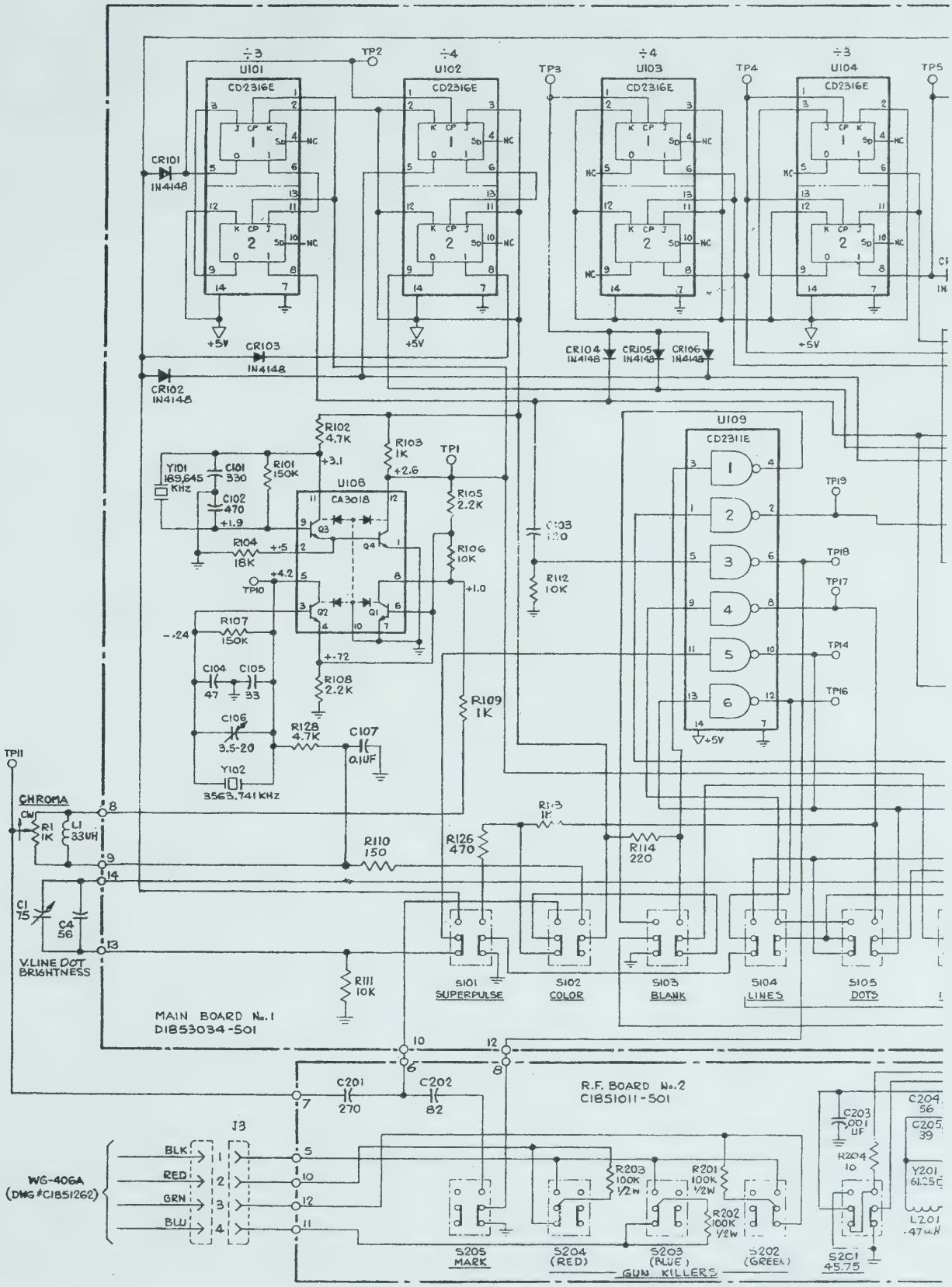
Figure 11. Component location on the RF printed circuit board. View from the component side.

Replacement Parts List
WR-515A Master CHRO-BAR Generator

When ordering replacement parts, include serial number and code number of instrument. Order parts by stock number, through a local RCA Distributor.

Symbol	Description	Stock No.
	RESISTORS	
	are ¼ watt, 5% unless otherwise noted.	
R1, R2	Var. Comp. 1k ohms 30%	422684
R3	Var. Comp. 200 ohms 30%	422690
R4	82k ohms 10% 1w	512382
R101	150k ohms	223770
R102	4.7k ohms	300739
R103	1k ohms	108865
R104	18k ohms	108870
R105	2.2 ohms	108866
R106	10k ohms	218499
R107	150k ohms	223770
R108	2.2k ohms	108866
R109	1k ohms	108865
R110	150 ohms	223770
R111, R112	10k ohms	218499
R113	1k ohms	108865
R114	220 ohms	502122
R115	10k ohms	218499
R116	1k ohms	108865
R117, R118	150 ohms	223770
R119	Variable, 10k ohms 30%	235507
R120	4.7k ohms	300739
R121, R122	15 ohms	235097
R123	18 ohms 5% 1w	512018
R124, R125	33 ohms 5% 1w	233931
R126	220 ohms	502122
R127	1k ohms	108865
R128	4.7k ohms	300739
R201 to R203	100k ohms 5% ½w	502410
R204	10 ohms	218499
R205 to R207	1.8k ohms	219460
R208	470 ohms	108864
R209	Variable, Linear 10k 30%	235207
R210	10 ohms	218499
R211, R212	470 ohms	108864
	CAPACITORS	
C1	Variable, 3.9-75pF	422689
C2	Electrolytic, 100μF 350V	422858
C3	Ceramic Disc, 470pF GMV	422856
C4	Ceramic Disc 10%, 1000V	230247
C101	Ceramic Disc, 330pF 10% 1000V	109295
C102	Ceramic Disc, 470pF GMV 1000V	109383
C103	Ceramic Disc, 180pF 10% 1000V	228290
C104	Ceramic Disc 47 10% 1000V	243311
C105	Ceramic Disc, 33 10% 1000V	261549
C106	Trimmer, 3.5-20pF 500V	422694
C107	Ceramic Disc, 0.1 μF 10V	218457
C108	Ceramic Disc, 330pF 10% 1000V	109295
C109	Electrolytic, 1200μF 10V	422688
C110	Electrolytic, 25μF 6V	422855
C111, C112	Electrolytic, 35μF 3V	223246
C113, C114	Ceramic Disc, 1000pF GMV 1000V	240846
C115	Ceramic Disc, .005μF 10% 1000V	922256
C116	Electrolytic, 2500μF 15V	424337
C117	Electrolytic, 50μF 6V	230967
C201	Ceramic Disc, 270pF 10% 1000V	107323
C202	Ceramic Disc, 82pF 10% 1000V	218773
C203	Ceramic Disc, 1000pF GMV 1000V	240846
C204	Mica, 56pF 5% 500V	219744
C205	Mica, 39pF 5% 500V	218099
C206	Ceramic Disc, .01μF 16V	422857
C207	Mica, 82 5% 600V	218221
C208	56pF 5% 500V	219744
C209	Ceramic Disc, 1000pF GMV 1000V	240846
C210	Ceramic Disc, .01μF 16V	422857
C211	Ceramic Disc, 27pF 10% 1000V	243310
C212	Ceramic Disc, 22pF 10% 1000V	244270
C213	Ceramic Disc, 6.8 pF 10% 1000V	419640
C215	Ceramic Disc, 330pF 10% 1000V	109295
CR101 thru CR109	Diode—Type 1N4148	240564
CR110	Diode—Type 1N3754	422674
CR111 to CR114	Diode—Type 40266	242226
CR115	Diode, Zener—Type 1N4733A	308635
CR201	Diode—Type 1N192	228050
U101 to U104	IC. Type CD2316E	422667
U105	IC. Type CD2305E	422666
U106, U107	IC. Type CD2316E	422667
U108	IC. Type CA3018V1	419643
U109	IC. Type CD2311E	422668
U110	IC. Type CD2309E	422669
U111	IC. Type CD2301E	422670
U112	IC. Type CA3020V1	422675
U201	IC. Type CA3018V1	419643
Y101	Crystal Unit—189.645 kHz	422850
Y102	Crystal Unit—3563-741 kHz	422851
Y201	Crystal Unit—61.25 MHz	422852
Y202	Crystal Unit—45.75 MHz	422853
L1	Inductor—33μH	243393
L101	not used	
L201	Inductor—47μH	243395
L202, L203	Inductor—Variable	243396
L204, L205	Inductor—1.5 μH	243394
S1	Switch—Rocker Dpst.	422691
S101/109	Switch—Pushbutton	422692
S201/205	Switch—Pushbutton	422693
T1	Transformer—Power	422849
J1, J2	Connector	098512
J3	Connector	101749
F1	Fuse, ⅛ A, GJV	423730
	Cover-Top & Bottom, Less Feet	422680
	Knob	422685
	Knob	422686
	Knob	422687
	Foot—for bottom of case	422935
	Power Cord	242516
	Cable-Gun Killer	422860
	Handle	
	PCB, Main	
	PCB, RF	

RCA


÷3
U101
CD2316E
TP2
÷4
U102
CD2316E
TP3
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U103
CD2316E
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U104
CD2316E
TP5
CR101
IN4148
CR102
IN4148
CR103
IN4148
CR104
IN4148
CR105
IN4148
CR106
IN4148
+5V
U109
CD2311E
TP19
TP18
TP17
TP14
TP16
TP1
TP10
TP11
U108
CA3018
Y101
189.645
KHz
C101
330
C102
470
R101
150K
R102
4.7K
R103
1K
R104
18K
R105
2.2K
R106
10K
R107
150K
R108
2.2K
R109
1K
C103
100
R112
10K
C104
47
C105
33
C106
3.5-20
R128
4.7K
C107
0.1UF
Y102
3563.741 KHz
+3.1
+2.6
+5
+4.2
+1.0
-.24
+.72
CHROMA
CW
R1
1K
L1
33uH
R110
150
R126
470
R113
1K
R114
220
C1
75
C4
56
V.LINE DOT
BRIGHTNESS
R111
10K
S101
SUPERPULSE
S102
COLOR
S103
BLANK
S104
LINES
S105
DOTS
MAIN BOARD No.1
D1853034-501
R.F. BOARD No.2
C1851011-501
C201
270
C202
82
J3
BLK
RED
GRN
BLU
WG-406A
(DWG #C1851262)
R203
100K
1/2W
R201
100K
1/2W
R202
100K
1/2W
S205
MARK
S204
(RED)
S203
(BLUE)
S202
(GREEN)
GUN KILLERS
C203
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UF
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S201
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C204
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C205
39
Y201
61.25
L201
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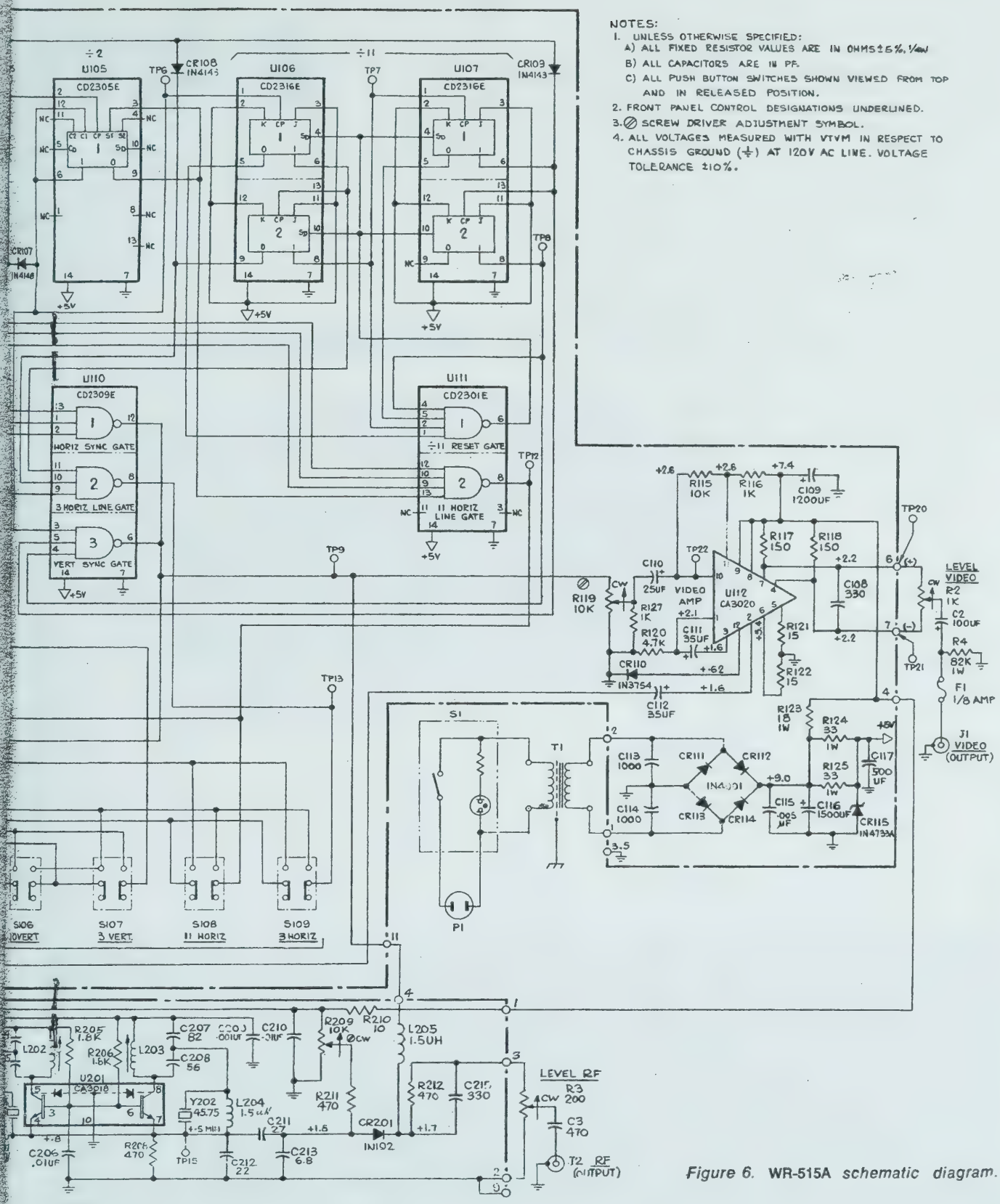

Figure 6. **WR-515A** *schematic diagram.*

SUGGESTED PRICE 50 CENTS
ISSUE 2

RCA

operating and
maintenance instructions

MASTER CHRO-BAR GENERATOR/SIGNALYST
Type WR-515A

RCA | Electronic Components | Harrison, N.J. 07029

Safety Precautions

Always become familiar with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below:

1. Always use an isolation transformer, such as the WP-25A Isotap, when working with AC/DC equipment having the chassis connected directly to one side of the AC power line. (Use the Isotap sockets marked "ISOLATED" for this purpose.)
2. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.
3. Filter capacitors may store a charge large enough to be lethal. Therefore, discharge filter capacitors before attaching test leads.
4. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.
5. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.
6. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in jeopardy of more serious risks, such as a bad fall or contact with a source of higher voltage.
7. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

Items Supplied with the WR-515A

- Shielded cable, with BNC connectors, WG-427A
- Direct/Isolation Adapter, WG-458A
- Matching Transformer, (75 to 300 Ohms) WG-451A
- Cable for gun-killer

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Description

The WR-515A Master Chro-Bar/Signalyst is the most advanced generator for television servicing ever developed by RCA. The many new features and functions of this unique instrument introduce entirely new concepts in color TV set-up and servicing procedures.

OUTPUT FOR ALL TEST SIGNALS IS PROVIDED NOT ONLY AT RF (CHANNEL 3*), BUT ALSO AT IF (45.75 MHz) AND VIDEO (4-5 MHz). This choice of output frequency provides servicing capabilities not possible with other generators. Now, you can use the output signals in stage-by-stage troubleshooting techniques, using the receiver screen to observe the effect of the patterns as they are processed by the various stages. By applying the signals at different points throughout the receiver, defective stages can often be isolated quickly. This method of troubleshooting can be particularly effective in servicing the new modular TV chassis.

Digital IC circuits are used in the WR-515A to provide solid, stable patterns over a temperature range of 75°F ± 70°, and a line voltage range of 120V ± 30V. There are no counter-alignment controls to require readjustment. All signals are derived from crystal-controlled oscillators.

The WR-515A provides the test signals required for adjusting convergence, color-phasing, gray-scale tracking, purity and linearity of color television receivers. Patterns include bars, dots, crosshatch, horizontal and vertical lines, and blank raster. The vertical and horizontal patterns can be selected in groups of three or ten lines. The output level of RF, IF, or video signals is adjustable. The vertical line and dot brightness is also adjustable.

The video output is low-impedance and will drive a 75-ohm video amplifier for closed-circuit TV system applications. A choice of positive or negative sync polarity is provided.

A new pattern called "SUPERPULSE" has been included in the WR-515A. This signal provides a white rectangle in the center of the screen. The SUPERPULSE has many applications, including adjusting gray-scale tracking (checks high-lights and low-lights simultaneously), and checking for

* The WR-515A can be operated on channel 4 by replacing the crystal as described on Page 14.

picture problems such as smearing, ringing, and video peaking. For troubleshooting applications, you can inject the SUPERPULSE signal at the RF, IF, or video test points, then with an oscilloscope, trace the waveforms through the receiver to locate the defective stage.

The color bar pattern provides ten bars simultaneously, including R-Y, B-Y, -(R-Y) I and Q signals, spaced at 30 degree phase intervals. This pattern is for use in checking color phase and matrixing circuits, and adjusting automatic frequency phase control (AFPC). Narrow brightness pulses are added at the edges of each color bar to aid in checking the "fit" or registration of the brightness and color signals. The color bar pattern is generated in a manner that establishes the background area between the bars at a luminance level approximately mid-way between black (no luminance) and full luminance (white). This permits AFPC alignment checks without using an oscilloscope.

A special color bar "mark" function places a brightness line on the 3rd, 6th and 9th (red, blue, and blue-green) bars. This feature provides positive identification of the bars, eliminating confusion that can arise if a bar is "missing" due to overscan, or if the colors are out of sequence due to AFPC misalignment.

The dot pattern provided by the WR-515A is used primarily in convergence adjustment. The pre-shoot and over-shoot area (small black edging preceding and following each dot) can be used to estimate the overall quality of the receiver alignment.

The crosshatch, vertical line, and horizontal line patterns are for use in adjusting linearity, overscan, and pincushion effect in both black and white and color receivers, and as an alternate pattern for adjusting convergence. The line and dot patterns can be selected in combinations of three or ten. The blank raster function provides a smooth, noise-free white raster as required for adjusting purity.

Color-coded pushbutton switches are included to short out the picture tube control grids as required in convergence and purity adjustments. A removable cable with special piercing clips is provided for connection to the grid leads of the picture tube guns. The Master Chro-Bar Generator operates from a standard 120-volt, 60 Hz power line. Accessories supplies includes the gun-killer cable, a shielded output cable, a 75-to-300-ohm matching transformer unit, and a direct/isolated output unit. A bracket is located on the rear of the instrument for convenient storage of the test leads.

Adjustment or Procedure	Recommended WR-515A Pattern
AGC	Lines; 10V, 11H
Video Peaking	Superpulse
H and V Centering	Lines; 3V, 3H
Purity	Blank Raster
Overscan	Lines; 3V, 3H
Linearity	Lines; 10V, 11H
Pincushion	Lines; 11H
Gray Scale Tracking	Superpulse
Convergence	
Static	Dot, Lines (3V, 3H) or Superpulse
Dynamic	Lines; 10V, 11H
AFPC (Tint)	Color Bars with "mark".
Troubleshooting	
Signal Injection	Superpulse, Color Bars, Lines
Signal Tracing	Superpulse, Color Bars

Specifications

Note: All signals are crystal-controlled.

RF OUTPUT

Frequency ..... Picture carrier 61.25 MHz. (Ch. 3)*
Impedance ..... 75 Ohms or 300 Ohms
Level ..... Adjustable up to 50 Millivolts (Across 300 Ohms)

IF OUTPUT

Frequency ..... 45.75 MHz
Impedance ..... 75 Ohms
Level ..... Adjustable up to 50 Millivolts

VIDEO OUTPUT

Frequency ..... 4-5 MHz
Impedance ..... 75 Ohms
Level ..... Adjustable up to 2 Volts (Across 75 Ohms)
Sync Polarity ..... Choice of Positive (+) or Negative (–)

TEST PATTERNS

Color Bars ..... Ten bars, spaced at 30° phase intervals. Includes R-Y, B-Y, -(R-Y), I, and Q signals. (Variable Chroma Level)

Dots .....
Crosshatch (H & V) ..... } Select pattern with 3 or 10 H & V lines.** V line and dot brightness
Horizontal Lines ..... } is adjustable with panel control.
Vertical Lines .....

Blank Raster ..... White, no-noise raster (Sync Modulation Only).
Superpulse ..... White rectangle centered on blank screen. For receiver adjustment and troubleshooting.

OTHER SIGNALS

Color Bar Mark ..... Identifying brightness line on leading edge of 3rd, 6th and 9th color bars (red, blue, and bluish-green).

POWER REQUIREMENTS ..... 120 V ± 30 Volts, 60 Hz., 5 Watts

TEMPERATURE RANGE ..... 75°F ± 70°

DIMENSIONS

Width ..... 10 Inches (15 cm)
Height ..... 4 Inches (10 cm)
Depth ..... 8 Inches (20 cm)

WEIGHT ..... Approximately 6 lbs. (2.7 Kg)

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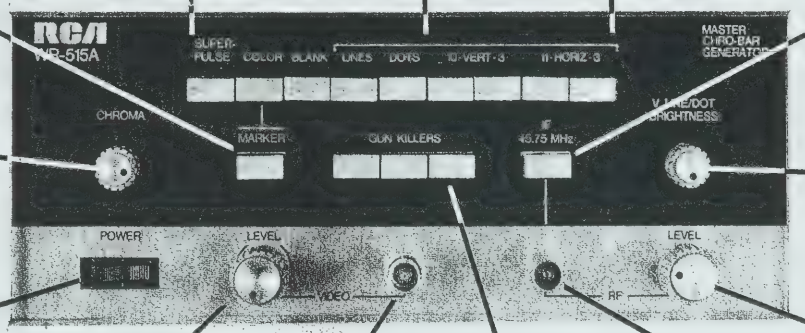
* The WR-515A can be operated on channel 4 by replacing the crystal as on page 14.

** The number of H lines generated is actually 11. On most receivers with normal overscan, only 10 will be seen.



Pattern Switches—Select Superpulse, Color Bars, Blank Raster, Lines, or Dots

Switches to select number of vertical and horizontal lines in the "LINES" and "DOTS" patterns.

Marker—Press to Add Identifying Markers to the 3rd, 6th, & 9th (red, blue, & bluish-green) color bars.

IF 45.75 MHz—RF/IF Selection Switch
Press for IF output, Release for RF output.

Chroma—Selects Amplitude of 3.58 MHz Color Subcarrier. Normally set to the mid-range position.

V Line/Dot Brightness—Varies Brightness of Vertical lines and dots.

Power—AC Power on Switch and Pilot Light

Level—Selects level of RF or IF signal.

Gun Killers—Switches short out red, blue, or green guns of picture tube. (Clip leads must be connected to control grids of picture tube).

Level—Selects Level and Sync Polarity of Video Signal

Video output connector.

RF (Ch. 3) and IF Output Connector.

Figure 1. WR-515A panel controls.

Operation

General

The following procedure describes the connections of the WR-515A to a TV receiver, and the method of obtaining the desired patterns on the receiver screen. For more detailed information for adjusting purity, linearity, convergence, etc., and for troubleshooting techniques, refer to the applications information supplied with the instrument.

Before using the generator with a particular TV receiver, check the operation of the receiver by observing the reception of a televised station signal. Adjust the receiver horizontal and vertical hold controls so that the picture is locked in properly, then set these controls to the center of their holding range. Switch out any special receiver controls such as AFT (automatic fine tuning) or automatic tint control.

Plug the generator power cord into a 120 volt, 60 Hz AC line, and turn on the instrument with the POWER switch.

Vertical-Retrace Lines

A few vertical retrace lines may appear in the upper section of the pattern generated by the WR-515A. This condition is normal, and does not affect the use of the instrument. These retrace lines will vary with TV receivers, and can be regulated to a certain extent by adjusting the receiver "vertical hold" control.

Hookup Procedure

RF SIGNAL INJECTION

1. Connect the WG-451A Matching Transformer to the WG-427A cable, and attach the cable to the RF output connector. Set the RF LEVEL control to mid-range. Be sure the "IF" pushbutton is released in the "OUT" position.

   Note: If the receiver has a direct 75-ohm input, the WG-427A can be connected directly to the input without using the WG-451A matching transformer. It may be necessary to use a special adapter BNC female to type "F" male adapter, (not supplied).
2. Disconnect the antenna from the receiver. Attach the WG-451A leads to the antenna terminals.
3. Set the receiver to Channel 3. Select the desired pattern, and adjust the receiver fine-tuning and other controls for the best picture.

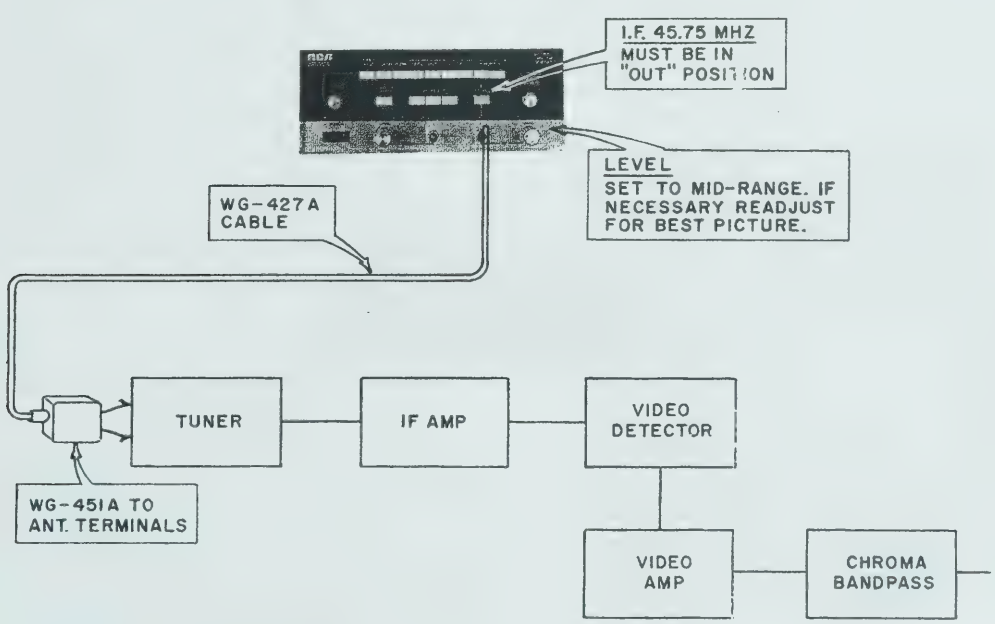


Figure 2. Hookup for RF signal injection.

IF SIGNAL INJECTION

1. Connect the WG-458A Direct Unit to the WG-427A cable, and attach the cable to the RF output connector. Press the IF 45.75 MHz pushbutton, and set the LEVEL control to mid-range.
2. Set the tuner to an unused channel, preferably on UHF. There should be no antenna connected to the receiver.
3. Connect the WG-458A adapter to the mixer input test point or other suitable test point in the IF amplifier. In some sets, the cable from the tuner to the IF stage can be unplugged. If so, the IF signal can conveniently be applied to this cable. This technique also has the advantage of completely isolating the IF stage from the tuner.
4. Adjust the generator controls to provide the desired pattern. Adjust the generator RF/IF LEVEL control and the receiver brightness and contrast controls for the best picture. If the signal is injected at other test points in the IF stage, it will usually be necessary to readjust the generator LEVEL control.

VIDEO SIGNAL INJECTION

1. Connect the WG-458A Direct Unit to the WG-427A cable, and connect the cable to the VIDEO output connector.
2. Set the receiver tuner to an unused channel, preferably on UHF. There should be no antenna connected to the receiver. In some sets, the cable from the tuner to the IF stage can be unplugged, further isolating the tuner from the rest of the receiver.
3. Connect the WG-458A to the input of the video stage (video detector output), or other suitable test point in the video or chroma stages.

   To protect the generator from damage when connecting the video output to a circuit having high B+ voltage, it is important that the yellow adapter lead be used. Use the red lead only when higher signal level is required, and when the test point has *less than 35 volts DC.* Connect the black lead to ground for all applications.

   FUSE PROTECTION—An internal fuse is installed in series with the video output connector. If B+ voltage above 35 volts is inadvertently connected to the red lead of the WG-458A, this fuse may burn out, resulting in loss of video output signal. Replace the fuse with the same type (GJV, 1/8 ampere). The fuse is accessible by removing the lower half of the case as described on page 14.
4. Turn on the receiver. Select the desired generator pattern, and set the VIDEO LEVEL control to "+" (clockwise) or "—" (counterclockwise) as required to produce a good picture on the screen. If the control is turned to the wrong polarity, the picture will be dark and there will be no sync. Turn the control in the proper direction until the picture begins to "tear," then back off the control just to the point where a good picture is obtained.
5. If the signal is applied to other test points in the video amplifier, it will be necessary to readjust the video level/polarity control. The video sync polarity may be inverted (reversed) at each stage of the amplifier.

   Caution: Always discharge (or ground) the WG-430A leads together when changing from one video test point to another. This is especially important when going immediately from a test point with B+ voltage to a vulnerable circuit point such as the input of a solid-state device. The generator video output is designed to discharge itself in about fifteen or twenty seconds, however.

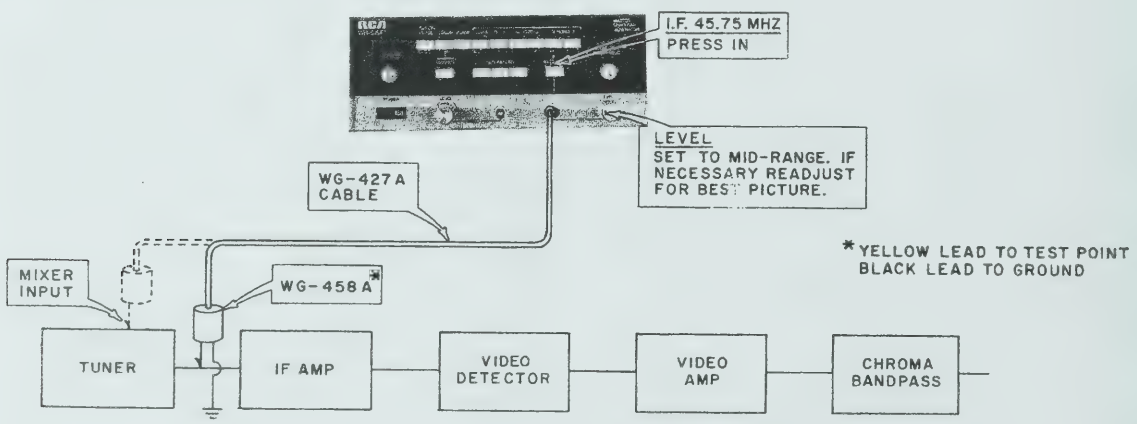


Figure 3. Hookup for IF signal injection.

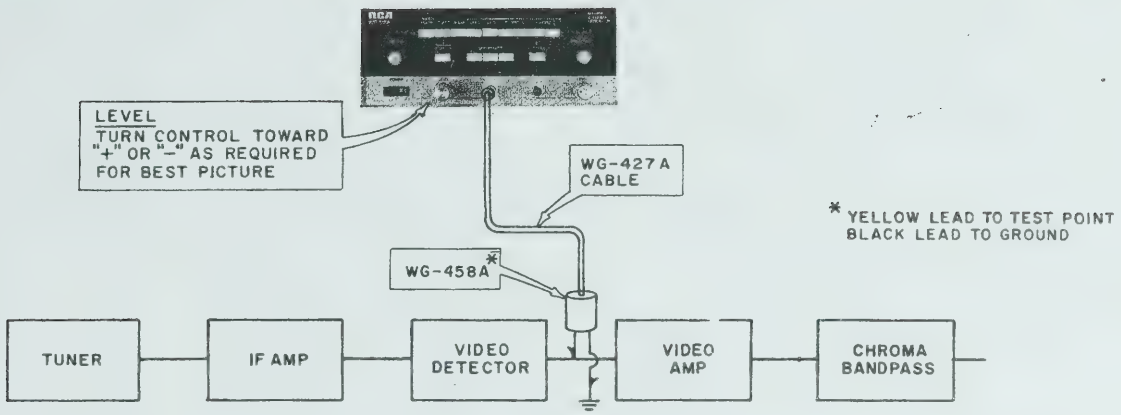


Figure 4. Hookup for video signal injection.

Pattern Selection

To select the desired pattern, just press the appropriate pushbutton; SUPERPULSE, COLOR (for color bars); BLANK (blank raster); LINES (for horizontal lines, vertical lines, or a crosshatch combination) or DOTS.

SUPERPULSE. The Superpulse pattern provides a white rectangular area in the center of the screen, similar to Figure 5. This pattern is useful for adjusting "gray-scale tracking," for evaluating general receiver performance, including purity, smear, ringing, and video peaking adjustment and as an alternate pattern for adjusting static convergence. For troubleshooting using a signal tracing technique, the Superpulse pattern is especially useful since it provides a simple, sharply defined oscilloscope waveform. Distortion or loss of gain in the pattern will be readily apparent.

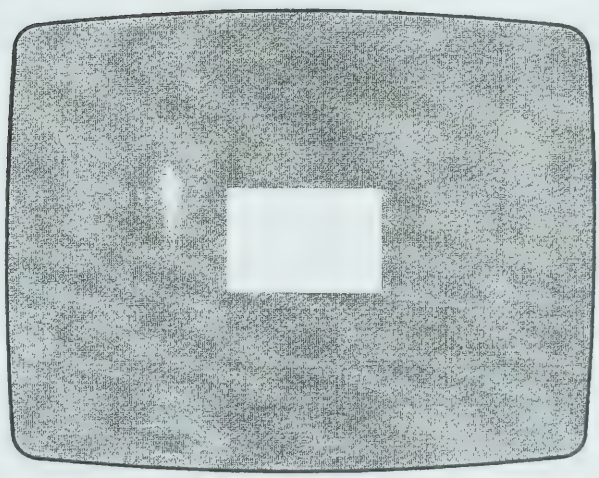
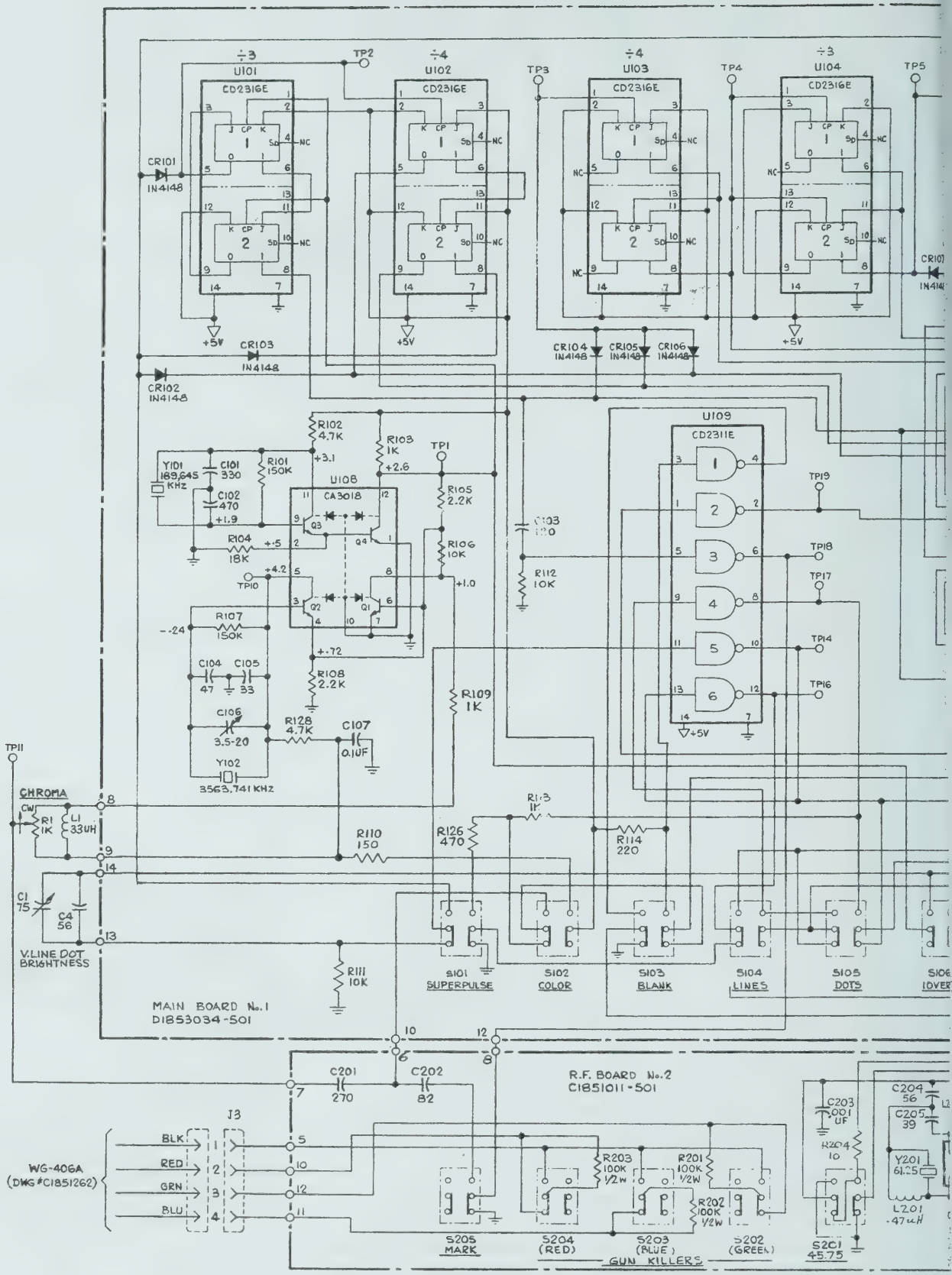


Figure 5. Superpulse pattern.


÷3
U101
CD2316E
TP2
÷4
U102
CD2316E
TP3
÷4
U103
CD2316E
TP4
÷3
U104
CD2316E
TP5
CR101
IN4148
CR102
IN4148
CR103
IN4148
CR104
IN4148
CR105
IN4148
CR106
IN4148
+5V
U109
CD2311E
TP19
TP18
TP17
TP14
TP16
U108
CA3018
Y101
189,645
KHz
C101
330
C102
470
R101
150K
R102
4.7K
R103
1K
TP1
R104
18K
R105
2.2K
R106
10K
C103
330
R112
10K
TP10
R107
150K
C104
47
C105
33
R108
2.2K
R109
1K
C106
3.5-20
R128
4.7K
C107
0.1UF
Y102
3563.741 KHz
TP11
CHROMA
CW
R1
1K
L1
33UH
R110
150
R126
470
R113
1K
R114
220
C1
75
C4
56
V.LINE DOT
BRIGHTNESS
R111
10K
S101
SUPERPULSE
S102
COLOR
S103
BLANK
S104
LINES
S105
DOTS
MAIN BOARD No.1
D1853034-501
C201
270
C202
82
R.F. BOARD No.2
C1851011-501
J3
WG-406A
(DWG #C1851262)
BLK
RED
GRN
BLU
R203
100K
1/2W
R201
100K
1/2W
R202
100K
1/2W
S205
MARK
S204
(RED)
S203
(BLUE)
S202
(GREEN)
GUN KILLERS
C203
.001
UF
R204
10
S201
45.75
C204
56
C205
39
Y201
6.125
L201
.47uH

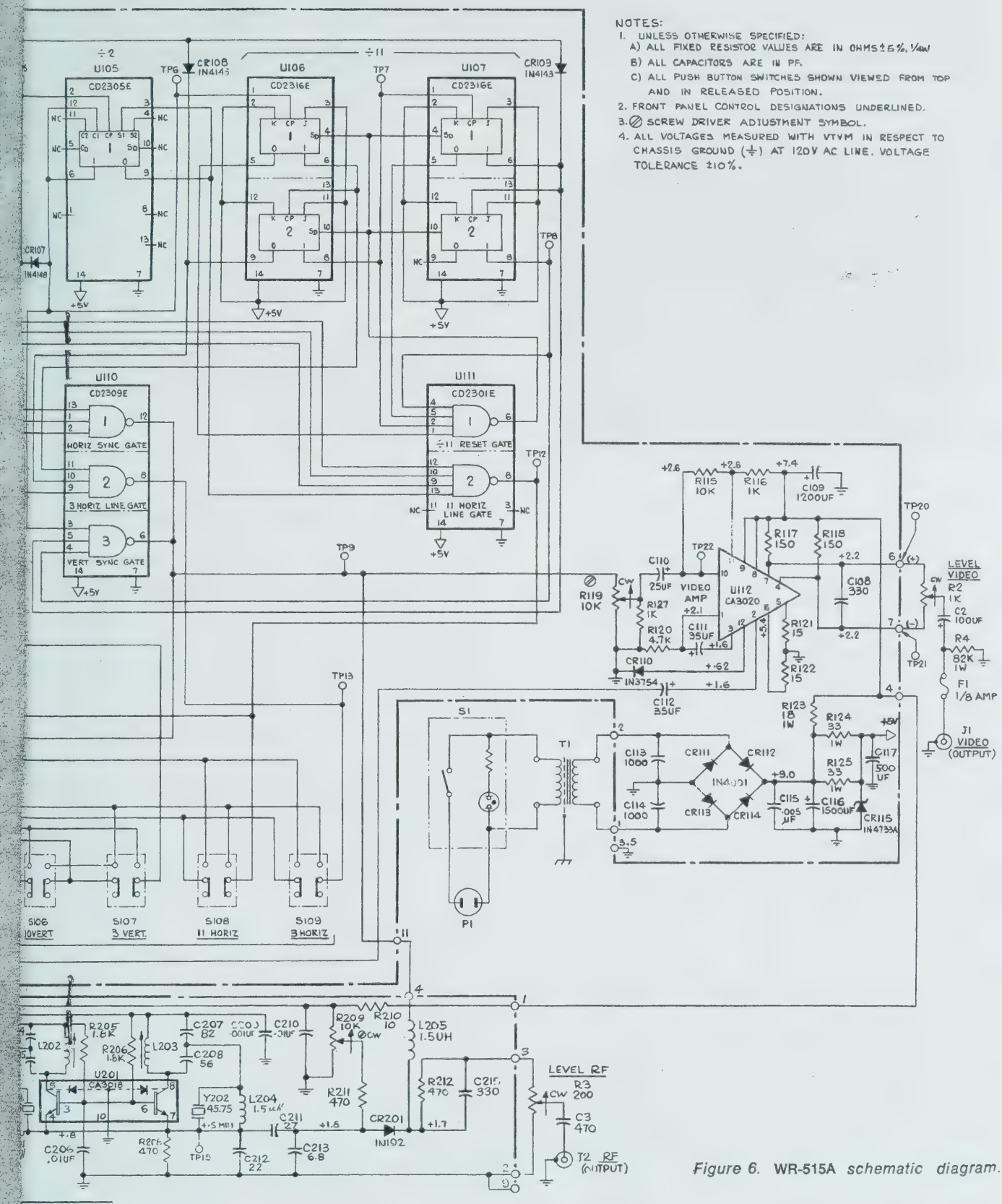


Figure 6. **WR-515A** *schematic diagram.*

COLOR BARS. The color bar pattern consists of ten color bars as shown in Figure 7. All ten bars may not always be entirely visible depending on the adjustment of the receiver horizontal centering and width adjustment. Set the receiver "color" control and the generator CHROMA control to mid-range.

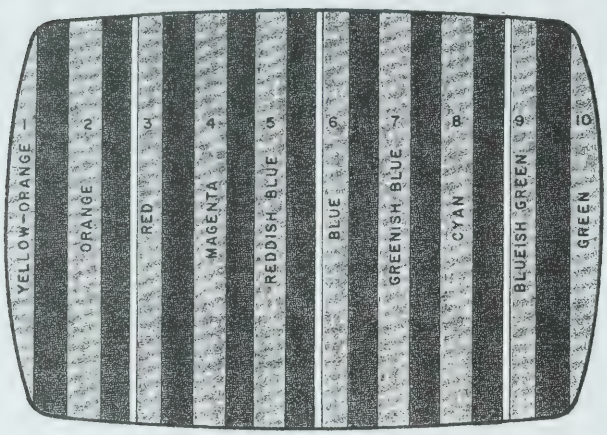


Figure 7. Color bar pattern, with bar marks on 3rd, 6th, and 9th bars.

Switch off any controls such as "Accutint" that restrict adjustment of tint. Adjust the receiver tint control so that the color bars appear as shown in Figure 7. The bars can be identified easily by pressing the MARK pushbutton. This will place a bright line on the 3rd, 6th, and 9th (red, blue, and blue-green) color bars. Readjust the generator CHROMA control to the minimum position that provides suitable color level.

BLANK RASTER. The blank raster pattern applies only sync modulation to the RF carrier, so that a white raster without "snow" is provided. The blank raster is especially designed for use in purity adjustments.

LINES AND DOTS. On the lines or dots function, you have a choice of 10 or 3 vertical and 11 or 3 horizontal lines (or rows of dots). *Note:* Although 11 horizontal lines are generated, on most receivers with normal overscan only 9 or 10 will be seen. To obtain horizontal or vertical lines alone, simply release both the 10 (11 for HORIZ) and the 3 pushbuttons for the other function. The brightness (or width) of the vertical lines or dots can be varied with the V LINE/DOT BRIGHTNESS control. Applications for the lines and dots functions include convergence, linearity, and overscan adjustments.

Note: If the vertical lines or vertical rows of dots do not appear, readjust the V LINE/DOT BRIGHTNESS control.

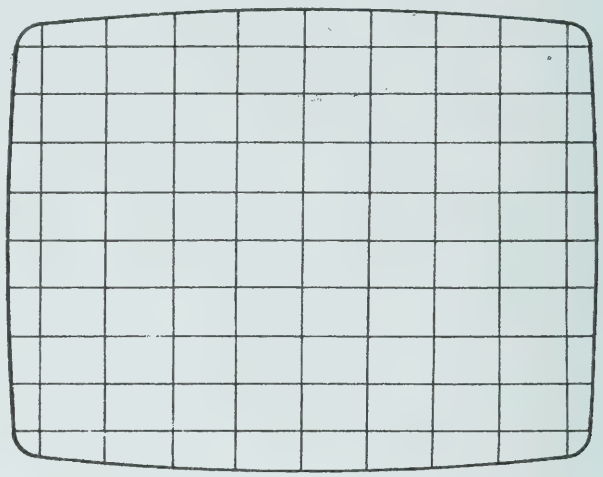


Figure 8. Line pattern showing horizontal and vertical lines. There are 11 horizontal and 10 vertical lines generated. Of these, only 9 or 10 lines will be seen with normal overscan adjustment.

A complete crosshatch pattern formed by all 10 vertical and horizontal lines is shown in Figure 8.

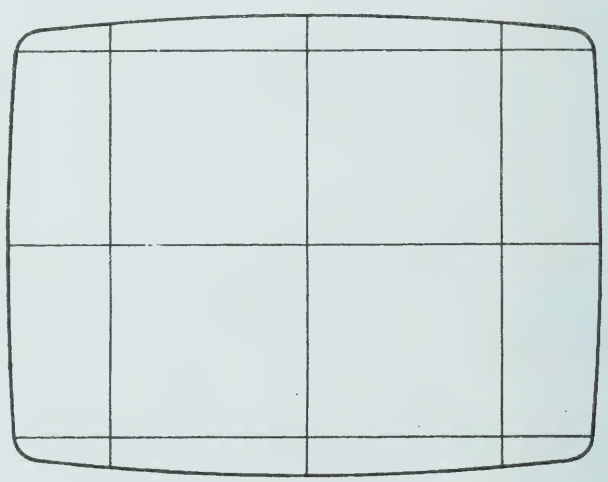


Figure 9. Line pattern with 3 horizontal and 3 vertical lines.

Gun-Killer Switches

Three switches are provided on the panel of the WR-515A for shorting out the color guns as required in convergence adjustment.

Procedure:

1. Turn off power to TV receiver. Plug the gun-killer switch cable into the receptacle on the rear panel of the Chro-Bar.
2. Connect the red, blue, and green leads from the cable to the corresponding grid-leads of the picture tube socket. It is not necessary to remove the socket from the color picture tube or make any direct connection to the socket pins. The special alligator clips will pierce the insulation on the grid lead and make contact with the wire. Position the lead in the clip so that the point of the piercing pin is centered over the wire, then force the jaws of the clip together.
3. Connect the black lead clip to the chassis ground of the receiver.
4. Turn on the TV receiver. Set the red, blue, or green gun switch to the "OFF" position to short out the corresponding color gun or guns. Return the switches to the "ON" position for normal operation of the color picture tube.

Circuit Description

The WR-515A Master Chro-Bar is a completely solid-state generator, providing color bars, dots, blank raster, V lines, H lines, crosshatch, and a new signal called "Superpulse." The instrument utilizes eleven digital IC's, and two IC transistor arrays. All signals produced by the generator are crystal controlled.

A 264 single-scan system is used rather than the 525-line interlace system. The 264-line raster has the advantage of providing small dots and single horizontal line registration with no flicker. The following output signals are developed in the generator:

Signal Frequency	*Function*
15804 Hz	H Sync
60 Hz	V Sync
61.25 MHz	Picture Carrier (Ch. 3)
3563.741 kHz	Color Off-Set Frequency
189.6 kHz	Vertical Lines (10)
47.4 Hz	Vertical Lines (3)
659 Hz	Horizontal Lines (10)
180 Hz	Horizontal Lines (3)
45.75 MHz	IF Output
4-5 MHz	Video Output
63 kHz	Bar Mark

A series of 13 flip-flop circuits are used to make a countdown from 189.6 KHz to 60 Hz. Starting with the 189.6 MHz master oscillator, four flip-flop circuits (U101 and U102) divide the signal by 12 to provide signals for the 3 and 10 vertical line patterns and horizontal sync.

The next division is by 24 (U103, U104, and U105), developing the horizontal line signals. The final count, divides the frequency by eleven (U106 and U107). It is the final count that provides the three horizontal-line signal and vertical sync.

Many of the intermediate frequencies provided by the countdown circuitry are used in the processing (gating) other signals.

The "gated-rainbow" color bar pattern is developed from the 3563.741 kHz oscillator (crystal Y102 and sections of U108). This frequency is off-set from the standard color subcarrier signal by 15,804 kHz, the horizontal frame frequency. As a result, a phase difference of 360 degrees occurs with each frame, producing a "rainbow" of color across the picture tube screen. This signal is used as a keyer to gate the signal at a 189 kHz rate, producing 12 color bars at 30 degree phase intervals. Two of the bars are eliminated during the sync interval. The color bar signal output is fed through the CHROMA LEVEL control, R1.

In the blank raster function, the function switch disables the vertical and horizontal signals so that only sync modulation is present.

All pattern signals are available at RF, IF, or video frequencies. For direct video output, the pattern signals are applied to an integrated circuit power amplifier (U112) used to provide power gain for the direct video output signal. This signal source can be used to drive low impedance video lines.

For RF or IF, the pattern or signal is applied to the CR201 modulator circuit. With the 45.75 MHz IF switch (S201) pressed, the 45.75 MHz circuit formed by crystal Y202 and ICU201 provide an IF carrier. With S201 released, the 61.25 MHz (Ch. 3) circuit formed by crystal Y201 and the other section of ICU201 provide an RF carrier.

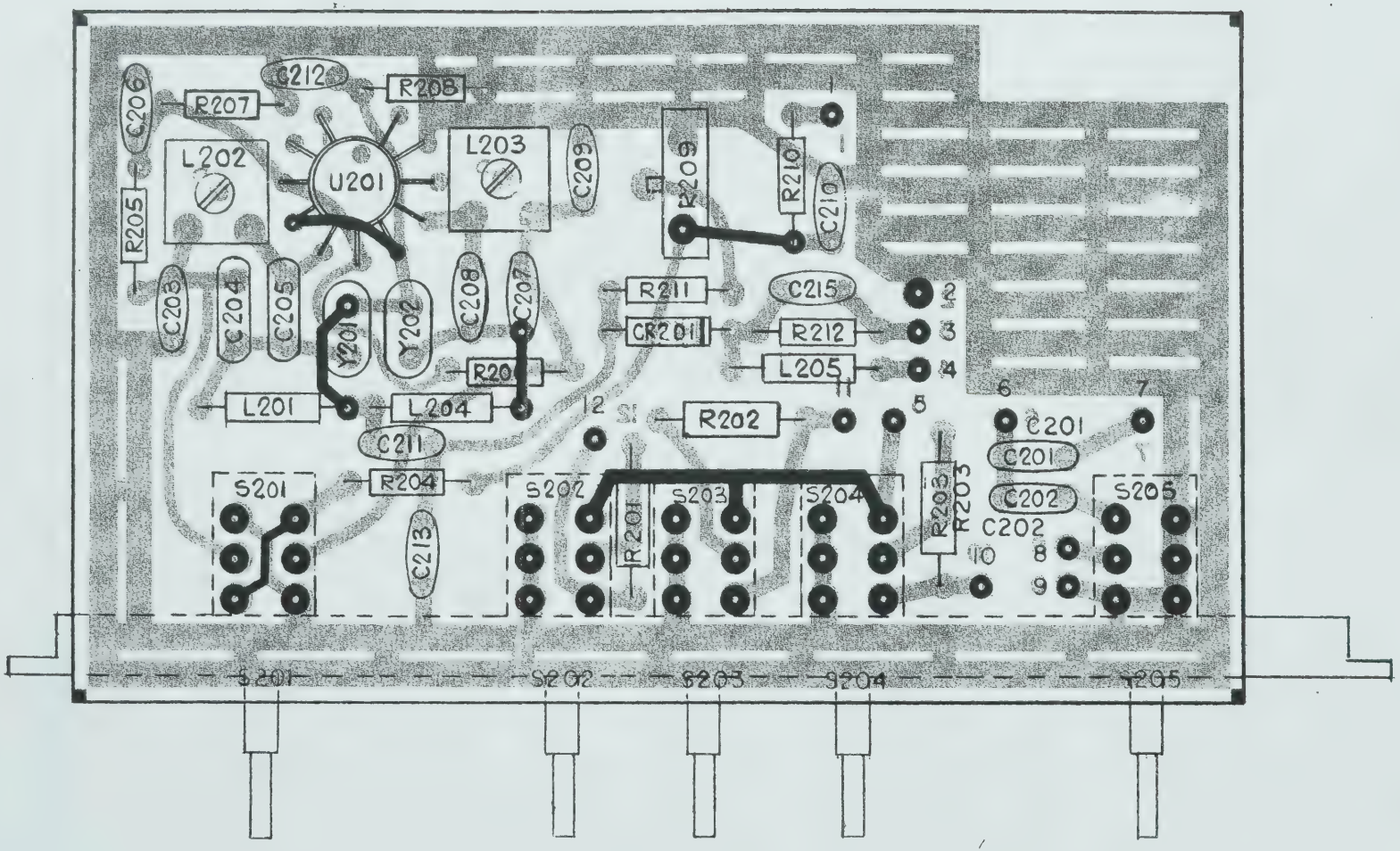


Figure 11. Component location on the RF printed circuit board. View from the component side.

Maintenance

General

The performance of the RCA CHRO-BAR Generator depends on the quality of the components. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. When ordering replacement parts, refer to the Parts List on page 17. The schematic diagram for the instrument is on pages 10 and 11. Further aids to servicing include the Circuit Description, page 13 and Figures 10 and 11, showing the location of components on the circuit board. The generator can be removed from the case by taking out the two screws on each side and four screws on the bottom.

RCA Repair Service

Authorized RCA Test Equipment Service Depots are available for repair and calibration of this equipment. For the name of the depot nearest you, contact your RCA Test Equipment distributor, or write to RCA Electronic Instruments, 415 South Fifth Street, Harrison, New Jersey 07029.

Fuse Replacement

An internal fuse is installed in series with the video output connector. If B+ voltage above 35 volts is inadvertently connected to the red lead of the WG-458A unit, this fuse may burn out, resulting in loss of video output signal. Replace the fuse with the same type (GJV, 1/8 ampere, RCA Stock No. 423730, or equiv.). The fuse is accessible by removing the lower half of the case as described below.

Removing the Case

To remove the case for servicing, take out the two screws on each side of the unit, loosen the handle knobs, and lift off the upper and lower case halves.

Operation on Channel 4

The unit is provided with a 61.25 MHz channel 3 crystal. In some areas however, the local channel station signal may be so strong that it causes interference with the generator pattern. In this situation, it is recommended that the crystal be replaced with a channel 4 crystal. The stock number for the crystal is 243333. Order from your local RCA Parts and Accessories Distributor. It will be necessary to readjust the RF oscillator as indicated below.

RF Oscillator Adjustment

The picture-carrier oscillator should require adjustment only if the crystal or component parts are changed.

1. Connect the WR-515A output cable to the antenna terminals of the receiver. Set the receiver to the same channel as the crystal in the RF oscillator of the generator.
2. Press the LINES switch, and the 10 VERT and 10 HORIZ switches to obtain a full crosshatch pattern. Adjust coil L202 slightly as necessary to obtain a crosshatch pattern on the TV receiver.
3. Turn the generator POWER switch on and off several times. The crosshatch pattern should lock in each time.

Modulation Level Adjustment

1. Connect the instrument to a TV receiver. Set the function switch to the DOTS position and obtain a crosshatch pattern on the receiver screen. Adjust the receiver brightness control so that there is no background brightness and only the dots are visible.
2. Using a small screwdriver, adjust the modulation level control, R209, (located near the center of the circuit board, near the large capacitor, C11) fully counterclockwise so that the background area of the pattern turns black.
3. Turn the control clockwise to the point where the dots "wash out" and cannot be seen, then counterclockwise just to the point where the dots appear.

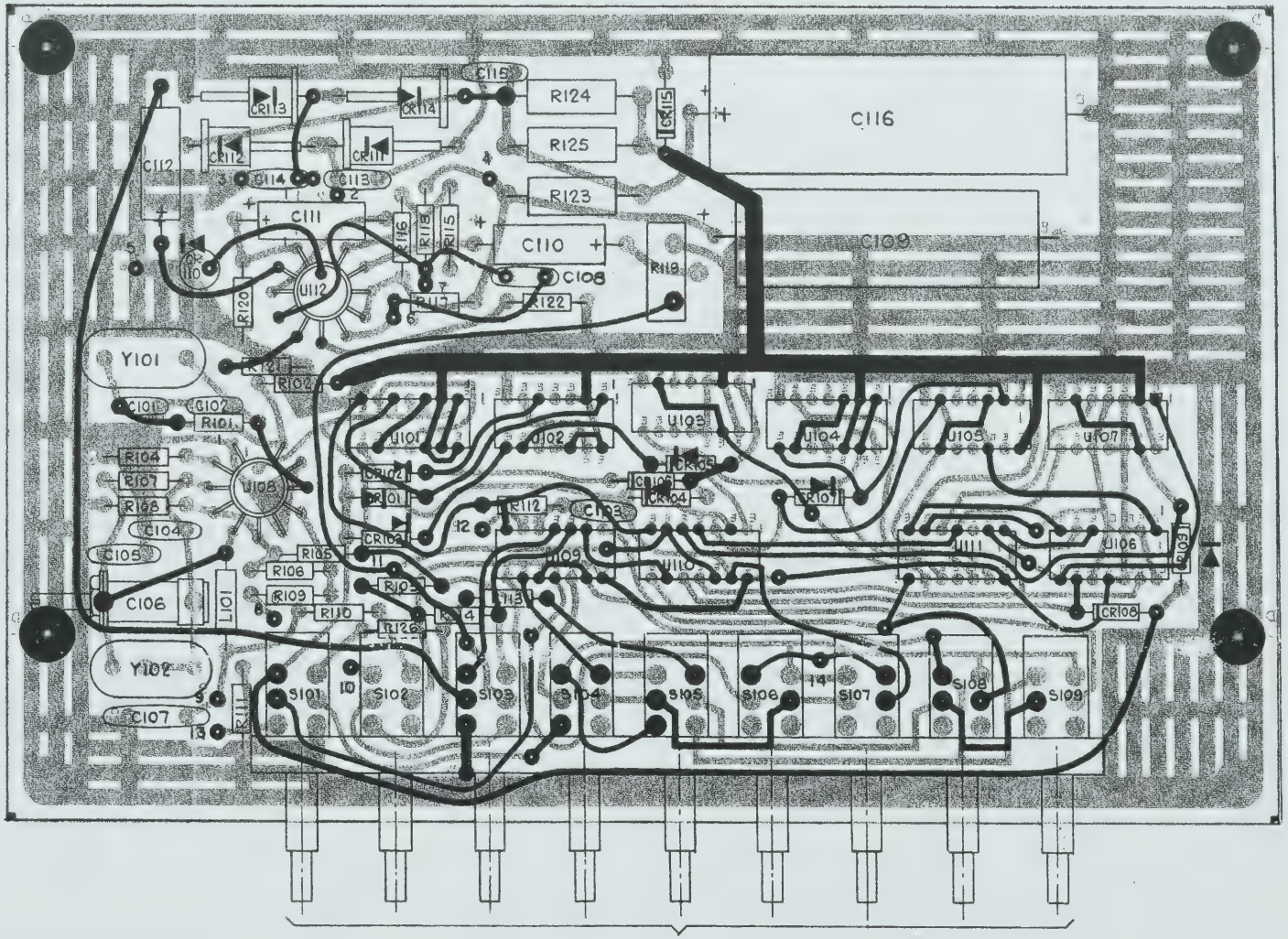


Figure 10. Component location on the main printed circuit board. View from the component side.

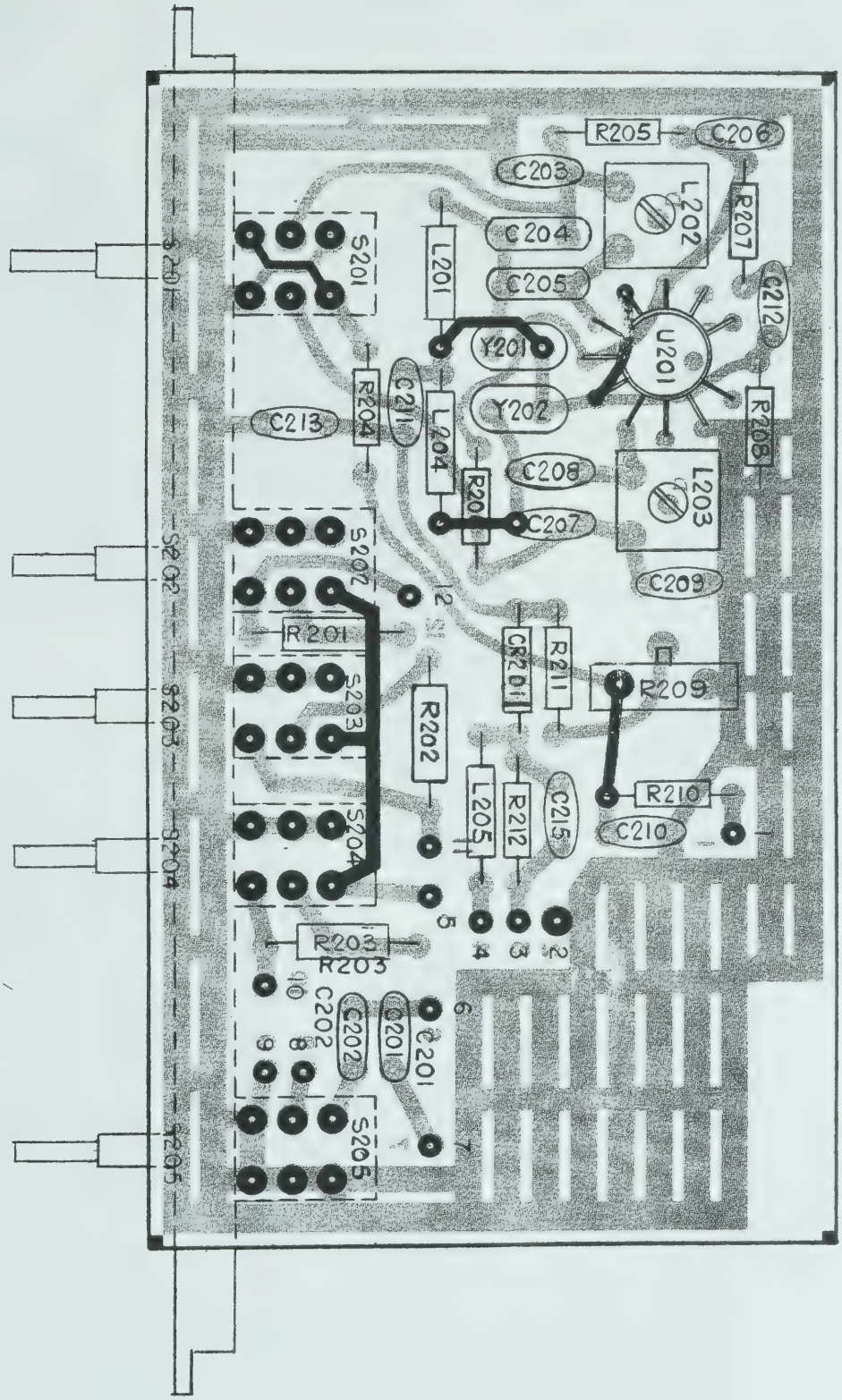


Figure 11. Component location on the RF printed circuit board. View from the component side.

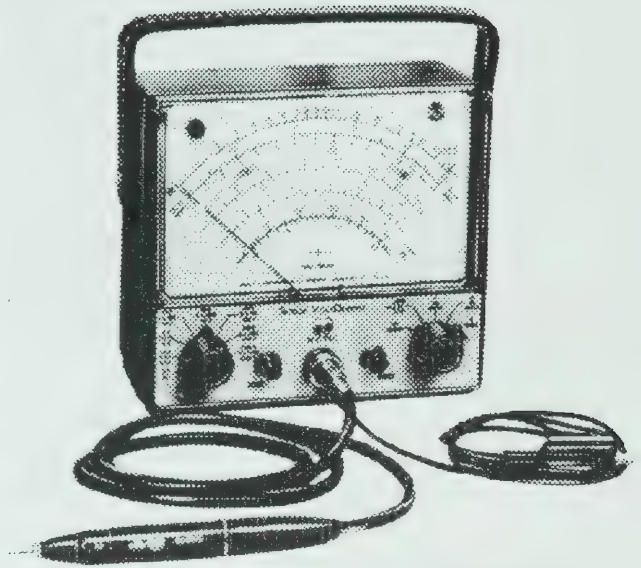
Replacement Parts List
WR-515A Master CHRO-BAR Generator

When ordering replacement parts, include serial number and code number of instrument. Order parts by stock number, through a local RCA Distributor.

Symbol	Description	Stock No.
	RESISTORS	
	are ¼ watt, 5% unless otherwise noted.	
R1, R2	Var. Comp. 1k ohms 30%	422684
R3	Var. Comp. 200 ohms 30%	422690
R4	82k ohms 10% 1w	512382
R101	150k ohms	223770
R102	4.7k ohms	300739
R103	1k ohms	108865
R104	18k ohms	108870
R105	2.2 ohms	108866
R106	10k ohms	218499
R107	150k ohms	223770
R108	2.2k ohms	108866
R109	1k ohms	108865
R110	150 ohms	223770
R111, R112	10k ohms	218499
R113	1k ohms	108865
R114	220 ohms	502122
R115	10k ohms	218499
R116	1k ohms	108865
R117, R118	150 ohms	223770
R119	Variable, 10k ohms 30%	235507
R120	4.7k ohms	300739
R121, R122	15 ohms	235097
R123	18 ohms 5% 1w	512018
R124, R125	33 ohms 5% 1w	233931
R126	220 ohms	502122
R127	1k ohms	108865
R128	4.7k ohms	300739
R201 to R203	100k ohms 5% ½w	502410
R204	10 ohms	218499
R205 to R207	1.8k ohms	219460
R208	470 ohms	108864
R209	Variable, Linear 10k 30%	235207
R210	10 ohms	218499
R211, R212	470 ohms	108864
	CAPACITORS	
C1	Variable, 3.9-75pF	422689
C2	Electrolytic, 100μF 350V	422858
C3	Ceramic Disc, 470pF GMV	422856
C4	Ceramic Disc 10%, 1000V	230247
C101	Ceramic Disc, 330pF 10% 1000V	109295
C102	Ceramic Disc, 470pF GMV 1000V	109383
C103	Ceramic Disc, 180pF 10% 1000V	228290
C104	Ceramic Disc 47 10% 1000V	243311
C105	Ceramic Disc, 33 10% 1000V	261549
C106	Trimmer, 3.5-20pF 500V	422694
C107	Ceramic Disc, 0.1 μF 10V	218457
C108	Ceramic Disc, 330pF 10% 1000V	109295
C109	Electrolytic, 1200μF 10V	422688
C110	Electrolytic, 25μF 6V	422855
C111, C112	Electrolytic, 35μF 3V	223246
C113, C114	Ceramic Disc, 1000pF GMV 1000V	240846
C115	Ceramic Disc, .005μF 10% 1000V	922256
C116	Electrolytic, 2500μF 15V	424337
C117	Electrolytic, 50μF 6V	230967
C201	Ceramic Disc, 270pF 10% 1000V	107323
C202	Ceramic Disc, 82pF 10% 1000V	218773
C203	Ceramic Disc, 1000pF GMV 1000V	240846
C204	Mica, 56pF 5% 500V	219744
C205	Mica, 39pF 5% 500V	218099
C206	Ceramic Disc, .01μF 16V	422857
C207	Mica, 82 5% 600V	218221
C208	56pF 5% 500V	219744
C209	Ceramic Disc, 1000pF GMV 1000V	240846
C210	Ceramic Disc, .01μF 16V	422857
C211	Ceramic Disc, 27pF 10% 1000V	243310
C212	Ceramic Disc, 22pF 10% 1000V	244270
C213	Ceramic Disc, 6.8 pF 10% 1000V	419640
C215	Ceramic Disc, 330pF 10% 1000V	109295
CR101 thru CR109	Diode—Type 1N4148	240564
CR110	Diode—Type 1N3754	422674
CR111 to CR114	Diode—Type 40266	242226
CR115	Diode, Zener—Type 1N4733A	308635
CR201	Diode—Type 1N192	228050
U101 to U104	IC. Type CD2316E	422667
U105	IC. Type CD2305E	422666
U106, U107	IC. Type CD2316E	422667
U108	IC. Type CA3018V1	419643
U109	IC. Type CD2311E	422668
U110	IC. Type CD2309E	422669
U111	IC. Type CD2301E	422670
U112	IC. Type CA3020V1	422675
U201	IC. Type CA3018V1	419643
Y101	Crystal Unit—189.645 kHz	422850
Y102	Crystal Unit—3563-741 kHz	422851
Y201	Crystal Unit—61.25 MHz	422852
Y202	Crystal Unit—45.75 MHz	422853
L1	Inductor—33μH	243393
L101	not used	
L201	Inductor—47μH	243395
L202, L203	Inductor—Variable	243396
L204, L205	Inductor—1.5 μH	243394
S1	Switch—Rocker Dpst.	422691
S101/109	Switch—Pushbutton	422692
S201/205	Switch—Pushbutton	422693
T1	Transformer—Power	422849
J1, J2	Connector	098512
J3	Connector	101749
F1	Fuse, ⅛ A, GJV	423730
	Cover-Top & Bottom, Less Feet	422680
	Knob	422685
	Knob	422686
	Knob	422687
	Foot—for bottom of case	422935
	Power Cord	242516
	Cable-Gun Killer	422860
	Handle	
	PCB, Main	
	PCB, RF	

SUGGESTED PRICE 50 CENTS

RCA



operating and
maintenance instructions

WV-38C Senior VoltOhmyst®

RCA | Electronic Components | Harrison, N.J. 07029

RCA

ITEMS

Supplied with the WV-98C

1 DC/AC-OHMS Probe and Cable ....Type WG-299E

1 1.5-Volt Battery .....Type VSO36

1 Slip-on Alligator Clip, with insulator

ACCESSORIES

Available on Separate Order

For measuring AC Voltages at Frequencies from 50 KHz to 250 MHz.

Crystal-Diode Probe .....Type WG-301A

For increasing DC Voltage to 50,000 volts:

High-Voltage Probe .....Type WG-411A
(Type WG-289 may also be used)

Multiplier Resistor .....Type WG-206

Note

The types WG-299A through WG-299E DC/AC-OHMS Probe and Cables can be used interchangeably with the WV-98C.

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Senior VoltOhmyst

Type WV-98C

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Safety Precautions

For proper operation, the ground lead of this instrument must be connected to the equipment under test. The WG-299E DC/AC-OHMS Probe and Cable has a shield throughout its entire length which is connected to the instrument ground. Always handle the WG-299E by the insulated probe housing.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. Always use an isolation transformer, such as the RCA WP-25A or WP-26A Isotap, when working with AC/DC equipment having the chassis connected directly to one side of the AC power line. (Use the sockets of the Isotap marked "ISOLATED" for this purpose.)

2. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be *especially careful* to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

3. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

4. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for fraved or broken insulation before working with them.

5. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

6. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

7. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

General Description

The WV-98C Senior VoltOhmyst® is an all electronic voltmeter designed to measure dc voltages, resistance, rms values of sine waves, and peak-to-peak values of complex waves. RMS ac and dc voltages up to 1500 volts may be measured with an accuracy of ±3% of full scale. Seven voltage ranges are provided for RMS ac operation, while eight ranges are provided for dc measurement, including a 0 to .5 volt range. Resistance values up to 1000 megohms, and complex waveforms having peak-to-peak values up to 4200 volts may also be measured. All measurements are made on a 6½ inch electronically protected meter.

An input resistance of 11 megohms on all dc-voltage ranges allows the WV-98C to be used in circuits where instruments with a lower impedance would result in loading of the circuit under test and a resultant error in reading the operating voltage. The 11-megohm input resistance also has the advantage of not being so high as to impair the stability of the instrument.

Calibration of the Senior VoltOhmyst in peak-to-peak voltage values as well as rms voltage values is a desirable feature for applications such as television, radar, and other pulsed electronic systems where complex waveforms are encountered. Because the meter reading is proportional to the full peak-to-peak value of the waveform, a better indication of the true value of the voltage is given than is possible with voltmeters which respond only to the positive or negative peak of the waveshape. Peak-to-peak voltage values are measured directly on separate meter scales.

When used to measure resistance, the WV-98C will read from 0.2 ohm to 1000 megohms in seven ranges. Convenient mid-scale values are set at 10, 100, 1000, 10,000, and 1000,000 ohms and at 1 and 10 megohms.

All measurements are made with a new single-unit probe, the WG-299E DC/AC-OHMS Probe and Cable. The probe is quickly adapted to either dc measurements, or ac and resistance measurements by means of a built-in switch. The fixed ground lead of the WV-98C insures good connection to the circuit under test.

The WV-98C is housed in a smartly-styled diecast aluminum case. The lightweight probe and cable supplied with the WV-98C has been designed to match the mechanical and electrical characteristics of the instrument

® Trade Mark "VoltOhmyst" Reg. U. S. Pat. Off.

Additional features of the WV-98C include provisions for zero-centering of the meter pointer, a useful feature for checking FM discriminator alignment; two separate scales for low-voltage ac measurements; a pilot light; and circuit design which permits measurements of the ac component of a dc voltage or the dc component of an ac signal. Circuit design also prevents any dc-loading effect when the WV-98C is used to measure ac voltages.

For measurement of ac voltages at frequencies up to 250 megacycles, the auxiliary WG-301A Crystal-Diode Probe may be used. The WG-301A slips on the front end of the WG-299E to form a sturdy, insulated rf probe without the addition of an extra cable.

For measuring dc voltages up to 50,000 volts, the WG-411A Slip-on High Voltage Probe may be used. The WG-411A attaches directly to the WG-299E probe.

The RCA WV-98C Senior VoltOhmyst is a versatile instrument, designed to give quality performance. A reliable measuring device, it enables the user to make a wide variety of accurate electrical measurements in many kinds of electrical equipment.

Specifications

Electrical

NOTE: Performance figures are for line voltage of 120 volts, 60 cps.

DC Voltmeter:

Ranges ..... 0 to .5, 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance (With switch on WG-299E set to "DC"):
All Ranges ..... 11 Megohms
Over-all Accuracy ..... ±3% of full scale

AC Voltmeter:

Ranges:
RMS Values of Sine Waves ....0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Peak-to-Peak Values of Sine Waves and Complex Waves ....0 to 4, 14, 42, 140, 420, 1400, 4200 volts

Over-all Accuracy ..... ±3% of full scale
(Accuracy of RMS ranges based on use of sine wave signals having less than ½ of 1.0% total harmonic content.)

Input Resistance and Capacitance
(With switch on WG-299E set to "AC-OHMS"):
1.5, 5, 50, 150-V Ranges ..... 0.83 meg, shunted by 70 pF
500-V Range ..... 1.3 meg, shunted by 60 pF
1500-V Range ..... 1.5 meg, shunted by 60 pF
Frequency Response
(1.5 and 5.0V AC Ranges) ..... ±1 db 30 Hz to 3 MHz

Maximum Input Voltages:

DC Voltages with no ac voltage present: ..... 1500 volts

AC Voltages with no dc voltage present:
RMS for Sine Waves ..... 1500 volts
Peak-to-Peak for Sine Waves ..... 4200 volts
Peak-to-Peak for Complex Waves ..... 2000 volts

Combined AC and DC Voltages:
Sum of DC Voltage and AC Peak Voltage ..... 2000 volts

Ohmmeter:

Ranges, Seven ..... 0 to 1000 megohms

Meter Movement:

DC Current for Full-Scale Deflection ..... 200μ amperes

Power Supply:

Voltage Rating ..... 110-130 volts

Frequency Rating ..... 50/60 Hz

Power Consumption (Approx.) ..... 6 watts

Battery (1.5-volt cell) 1 RCA-VS036

Tube Complement: 1 RCA-6AL5, 1 RCA-12AU7A

Over-all Dimensions:

Height ..... 6½ inches

Width ..... 7 inches

Depth ..... 3¾ inches

Weight: ..... 6 pounds

Finish: ..... Blue-gray hammertone case—satin aluminum panel

Functions of Controls

FUNCTION SELECTOR – Applies power to the instrument when this control is turned clockwise from the "OFF-TRANSIT" position and selects the measurement function of the instrument. When this switch is set to the "OFF-TRANSIT" position, power is removed and, a short is placed across the meter terminals to lock meter pointer electrically in the zero position, thereby reducing the possibility of damage to the meter movement when the instrument is being transported.

RANGE SELECTOR – Selects the voltage range or the resistance range on which the measurement is to be made.

ZERO control – Used to position the meter pointer at either the left-hand "0" position or, when function selector is set to "+DC VOLTS", to the zero-center "0" position.

OHMS control – Used to position the meter pointer at the extreme right line on the "R" scale when the function selector is set to "R OHMS".

Operation and Application

Use of WG-299E Probe and Cable:

The WG-299E DC/AC-OHMS Probe and Cable, supplied with the WV-98C, is constructed as a single-unit probe and cable and is equipped with a sliding switch in the probe body to permit changing the probe characteristics to suit the type of measurement being made. When the sliding switch is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the WV-98C. This resistor acts to isolate the instrument from the circuit under test when dc-voltage measurements are made and is a part of the over-all input resistance of the voltmeter. The switch should always be set to the "DC" position when dc-voltage measurements are made.

When the sliding switch is set to the rear of "AC-OHMS" position, the isolating resistor is shorted out and the signal or test voltage is fed directly from the probe tip to the input of the WV-98C. The switch should always be set to the "AC-OHMS" position when resistance or ac-voltage measurements are made.

Preliminary Adjustments:

To prepare the WV-98C for use, make the following connections and adjustments:

1. Connect the WG-299E DC/AC-OHMS Probe and Cable to the front-panel connector.

2. Plug the power cord into an ac outlet supplying 110-130 volts at 50-60 cps and adjust the controls as follows:

a. Set the function selector to "+DC VOLTS" and the range switch to the "1.5V" position. Allow a few minutes for the instrument to warm up.

b. Adjust the ZERO control to position the meter pointer at the left-hand zero on the scales.

c. Turn the function selector to "R OHMS". The pointer should deflect to approximately full scale.

d. Rotate the OHMS control to position the pointer at the last line on the "R" (ohms) scale.

e. Turn the function selector to the "AC" position. The pointer should deflect back to the left-hand zero. The instrument is now ready for use.

Use of Range Switch and Meter Scales

The meter scales on the WV-98C have been designed to provide ease of operation and quick readability over a wide range of measurements. Scales are grouped conveniently for the type of measurement for which they are used. The "R" scale, at the top of the scale plate, is used only for resistance measurements, and all resistance measurements are read from this one scale. All dc voltages are read from the two scales marked "A" and "B" in Figure 1. The six remaining scales are used only for ac-voltage measurements. The rms values of sine-wave voltages are also read from scales marked "A", "B", plus the two low AC scales, "G" and "H". The corresponding peak-to-peak values are read from scales marked "C", "D", "E", and "F". The particular scale which is used for any given function is determined by the setting of the range switch.

Table I has been prepared as an aid in selection of ranges, scales, and multiplying factors for all measurements which can be made with the WV-98C.

Because of the wide number of measurement ranges provided on the WV-98C, it is often possible to take voltage or resistance reading on two ranges and scales. For greatest accuracy in voltage measurements, always use the range which will provide an on-scale reading which is nearest to the full-scale point. For example, 48 dc volts can be read from either the 50-volt or the 150-volt range. Because the 50-volt range will provide a reading nearest the full-scale point, the 50-volt range only should be used

(continued on page 12)

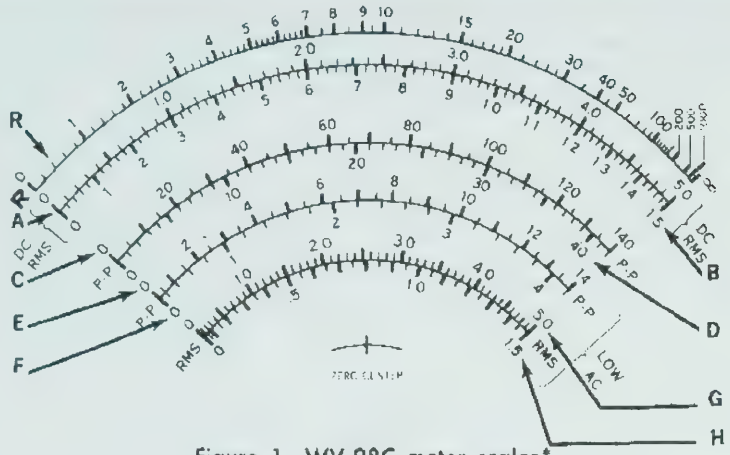


Figure 1. WV-98C meter scales*

TABLE 1
RESISTANCE MEASUREMENTS

(Set Function switch to "R OHMS" and set WG-299E switch to "AC-OHMS".)

Resistance to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0.2 to 1000Ω	R X 1	R	1
1000 to 10000Ω	R X 10	R	10
10000 to 100000Ω	R X 100	R	100
100000Ω to 1 MEG	R X 1000	R	1000
1 MEG to 10 MEG	R X 10K	R	10000
10 MEG to 100 MEG	R X 100K	R	100000
100 MEG to 1000 MEG	R X 1 MEG	R	1 MEG

DC-VOLTAGE MEASUREMENTS

(Set Function switch to "−DC VOLTS" or "+DC VOLTS" and set WG-299E switch to "DC".)

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
0 to .5V	.5V DC	A	.1
.5 to 1.5V	1.5V	B	.1
1.5V to 5V	5V	A	1
5 to 15V	15V	B	1
15 to 50V	50V	A	10
50 to 150V	150V	B	10
150 to 500V	500V	A	100
500 to 1500V	1500V	B	100

*In some units 0 to 15 DC/RMS scale is marked 0 to 1 5. Also, low AC and P-P scales may be interchanged

AC RMS VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299E switch to "AC-OHMS".)

RMS voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent peak-to-peak-value: Use Scale	Multiply by
0.1 to 1.5V	1.5V	H	1	F	1
1.5V to 5V	5V	G	1	E	1
5 to 15V	15V	B	1	D	1
15 to 50V	50V	A	10	C	1
50 to 150V	150V	B	10	D	10
150 to 500V	500V	A	100	C	10
500 to 1500V	1500V	B	100	D	100

AC PEAK-TO-PEAK VOLTAGE MEASUREMENTS

(Set Function switch to "AC" and set WG-299E switch to "AC-OHMS".)

Peak-to-peak voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by	To get equivalent RMS value: Use Scale	Multiply by
0.2 to 4V	4.0V	F	1	H	1
4 to 14V	14V	E	1	G	1
14 to 40V	40V	D	1	B	1
40 to 140V	140V	C	1	A	10
140 to 400V	400V	D	10	B	10
400 to 1400V	1400V	C	10	A	100
1400 to 4200V	4000V	D	100	B	100

NULL INDICATIONS (DC VOLTS)

(See paragraph titled "Zero-Center Indication")

Voltage to be measured	Set Range Switch to:	Read from Scale	Multiply Reading by
−.75 to +.75V	1.5V	B	.1
−2.5 to +2.5V	5V	A	1
−7.5 to +7.5V	15V	B	1
−25 to +25V	50V	A	10
−75 to +75V	150V	B	10
−250 to +250V	500V	A	100
−750 to +750V	1500V	B	100

if a reading of best accuracy is to be obtained. This general rule applies to all ac- and dc-voltage ranges. For ohms measurements, however, the range selected should be the one which provides a reading nearest the *center* of the scale because the VoltOhmyst provides the most accurate readings at mid-scale points.

For some measurements it will be necessary to use a multiplying factor with the scale reading to obtain the correct reading. The required multiplier is indicated by the setting of the range switch. These ranges correspond to the full-scale values shown on the right side of the meter scales. For example, when the range switch is set to the 500-volt position for a dc-voltage measurement, the "A" scale (Figure 1) is used. Because this scale has a full scale value of "5", it is necessary to multiply any readings on this scale by 100 to obtain the correct value.

DC-Voltage Measurements

NOTE: The sliding switch on the WG-299E should be set to "DC" for all dc-voltage measurements. Maximum input voltages must not be exceeded. See "Specifications" and "Safety Precautions".

The WV-98C has eight dc-voltage ranges: 0 to .5, 1.5, 5, 15, 50, 150, 500, and 1500 volts. Although the meter is protected against burn-out under ordinary overloads, it is good practice to make a trial measurement at a range setting higher than the voltage expected. Continued or repeated overloads may impair the accuracy of the movement. To measure dc voltages, proceed as follows:

1. Set the function selector to "−DC VOLTS" or to "−DC VOLTS", as required.
2. Connect the clip of the ground cable to the ground of the circuit under test.
3. Set the range selector to a range position higher than the voltage to be measured.
4. Touch or connect the probe tip to the high side of the source voltage.
5. Reset range selector to a position which gives a reading nearest to full scale.

NOTE: When the ".5V DC" position is used, remove the probe tip from the voltage being measured and re-set the ZERO control to position the meter pointer at the left-hand "0".

6. Read the dc voltage from the scale corresponding to the range selector setting.

Zero-center indication is frequently useful because it allows observation of either positive or negative dc-voltage excursions without the necessity of resetting the function selector.

1. Set the function selector to "±DC VOLTS".
2. Rotate the ZERO control to position the pointer at the center "−0+", which is located near the bottom center of the meter dial. If the

ZERO control does not have sufficient range to center the pointer, switch the function selector to "−DC VOLTS".

3. Set the range selector to a position at least twice the voltage to be measured.
4. After a test reading has been made, the range control may be set to the lowest position which allows the pointer to remain on the scale.

Resistance Measurements

NOTE: The sliding switch on the WG-299E probe should always be set to "AC-OHMS" when resistance measurements are to be made.

CAUTION: The power should be removed from the equipment under test, and any capacitors should be discharged so that no voltages are present in them.

1. Set the function selector to the "R OHMS" position.
2. Set the range selector to the "R x 10" position.
3. Short the probe tip to the ground cable and adjust the ZERO control to position the pointer at the left-hand "0", if necessary.
4. Separate the probe tip from the ground cable. The meter pointer should deflect to full scale. If the meter pointer does not deflect to exactly full scale, use the OHMS control to obtain full deflection.
5. Connect the clip of the ground cable to one terminal of the resistance to be measured.
6. Touch or connect the probe tip to the other terminal of the resistance to be measured.
7. Reset the range control to give a convenient deflection on the "R" (ohms) scale.

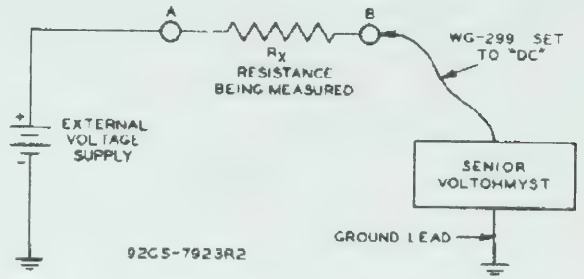


Figure 2. Circuit for resistance measurements above 1000 megohms

8. Multiply the reading on the "R" scale by the factor indicated by the range control setting.

CAUTION: Low-current, low-resistance devices, such as thermocouples and meter movements, may be damaged unless a range higher than "R x 10" is used because the WV-98C applies up to 1.5 volts across the resistance under measurement when the range control is set at "R x 1" or "R x 10".

Measurement of Resistance Values Above 1000 Megohms.

The leakage resistance of small mica and paper capacitors is usually above 1000 megohms. The circuit shown in Figure 2 can be used to measure resistance values above 1000 megohms. An external dc-voltage source between 20 and 500 volts is utilized to obtain a measurable pointer deflection. Make circuit connections as shown in Figure 2 and proceed as follows:

1. Set function selector to "+DC VOLTS" and measure the voltage at point B.
2. Measure the voltage at point A.
3. Compute the unknown resistance from the following formula:

$$Rx\ (\text{megohms}) = \frac{11\ [(\text{Volts at "A"}) - (\text{Volts at "B"})]}{(\text{Volts at "B"})}$$

EXAMPLE: The value of an unknown resistance is to be determined with the circuit of Figure 2. An external voltage of 500 volts is applied. The WV-98C measures 2.5 volts at "B", and 500 volts at "A". Then,

$$Rx = \frac{11\ (500\text{-}2.5)}{2.5} = 2200 \text{ megohms (approx.)}$$

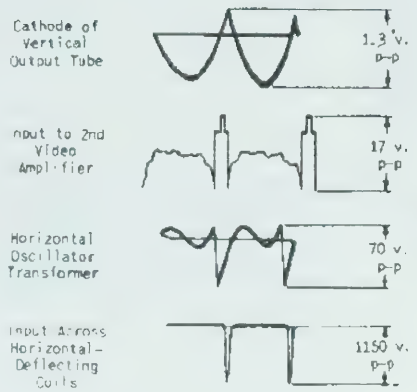


Figure 3. Typical television waveforms

AC-Voltage Measurements

CAUTION: Maximum input voltages must not be exceeded. The accuracy of meter indications is dependent upon the frequency of the ac voltage being measured, the waveshape, repetition rate, and the impedance of the voltage source. See "Specifications", page 6, and the section below for additional information.

The switch on the WG-299E Probe should be set to "AC-OHMS" for all ac-voltage measurements.

1. Set the function selector to "AC".
2. Adjust the ZERO control if necessary to position the meter pointer at the left-hand "0".
3. Set the range control to a position considerably higher than the voltage to be measured.
4. Connect the ground cable to the ground side of the voltage to be measured.
5. Touch or connect the probe tip to the high side of the source voltage.
6. Reset the range control for a convenient deflection.
7. Read the ac voltage from the scale corresponding to the range control setting.

The meter scales of the WV-98C are calibrated in both rms and peak-to-peak voltages. Peak-to-peak voltage values are read from the red scales marked "P-P"; rms values of sine waves are read from the black scales marked "RMS".

NOTE: When it is desired to know which peak-to-peak scale is used, the indication is taken from the markings on the range-switch positions. Position 2, for example, is labeled "1.5V" and "4". These figures correspond to the full-scale values of the corresponding rms and peak-to-peak scales. (Scales "H" and "F" in Figure 1.)

Examples of typical voltage waveforms found in television circuits are shown in Figure 3. Examples of other types of basic waveforms which can be measured by the WV-98C are shown in Figure 4.

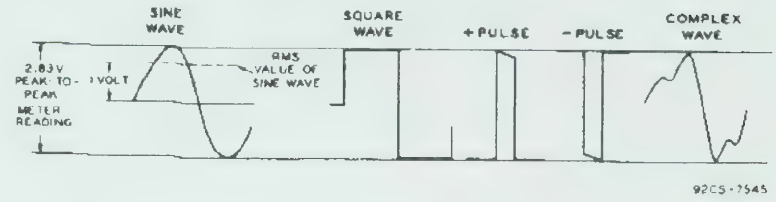


Figure 4. Typical voltage waveforms

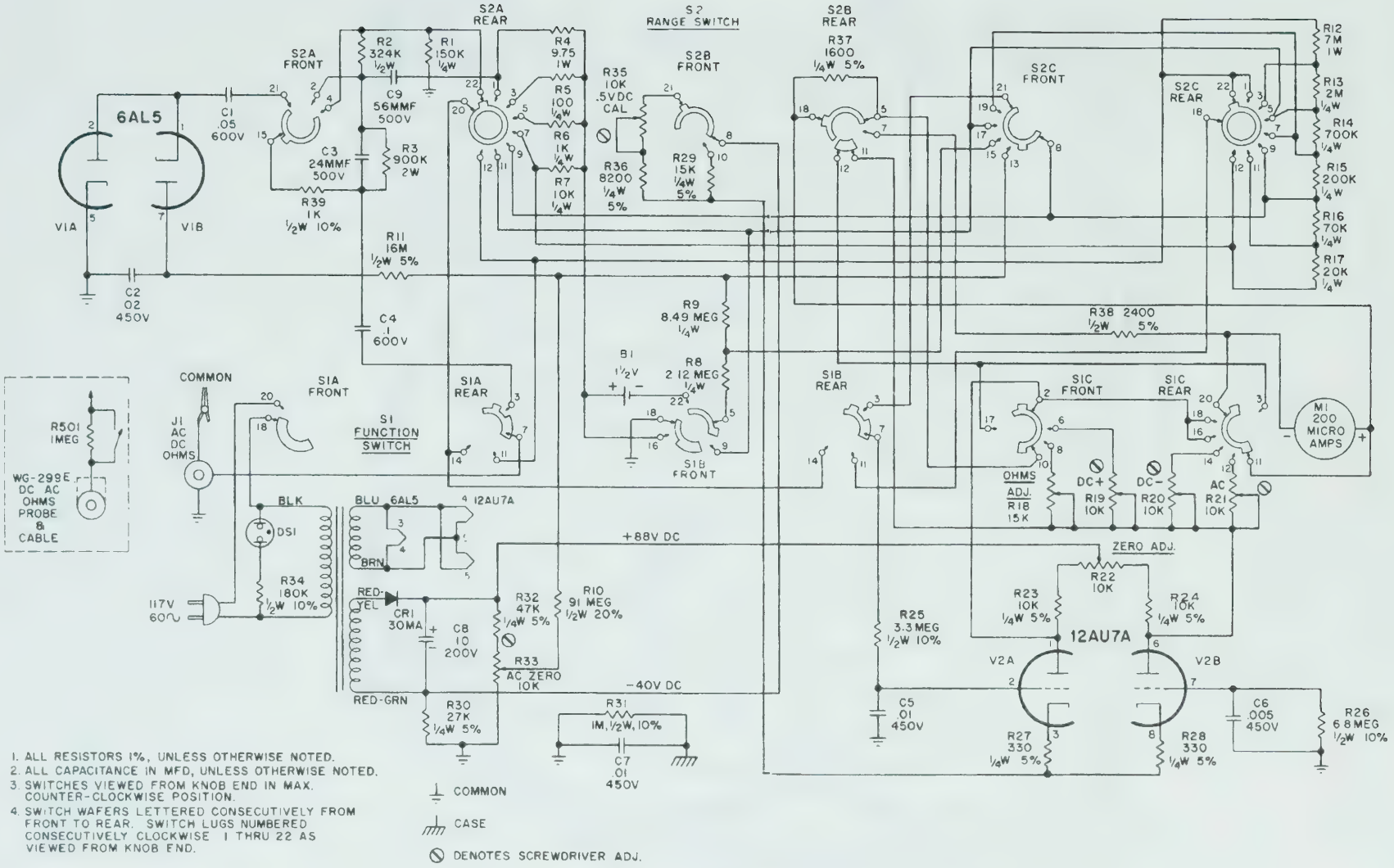


Figure 5. Schematic diagram of the WV-98C

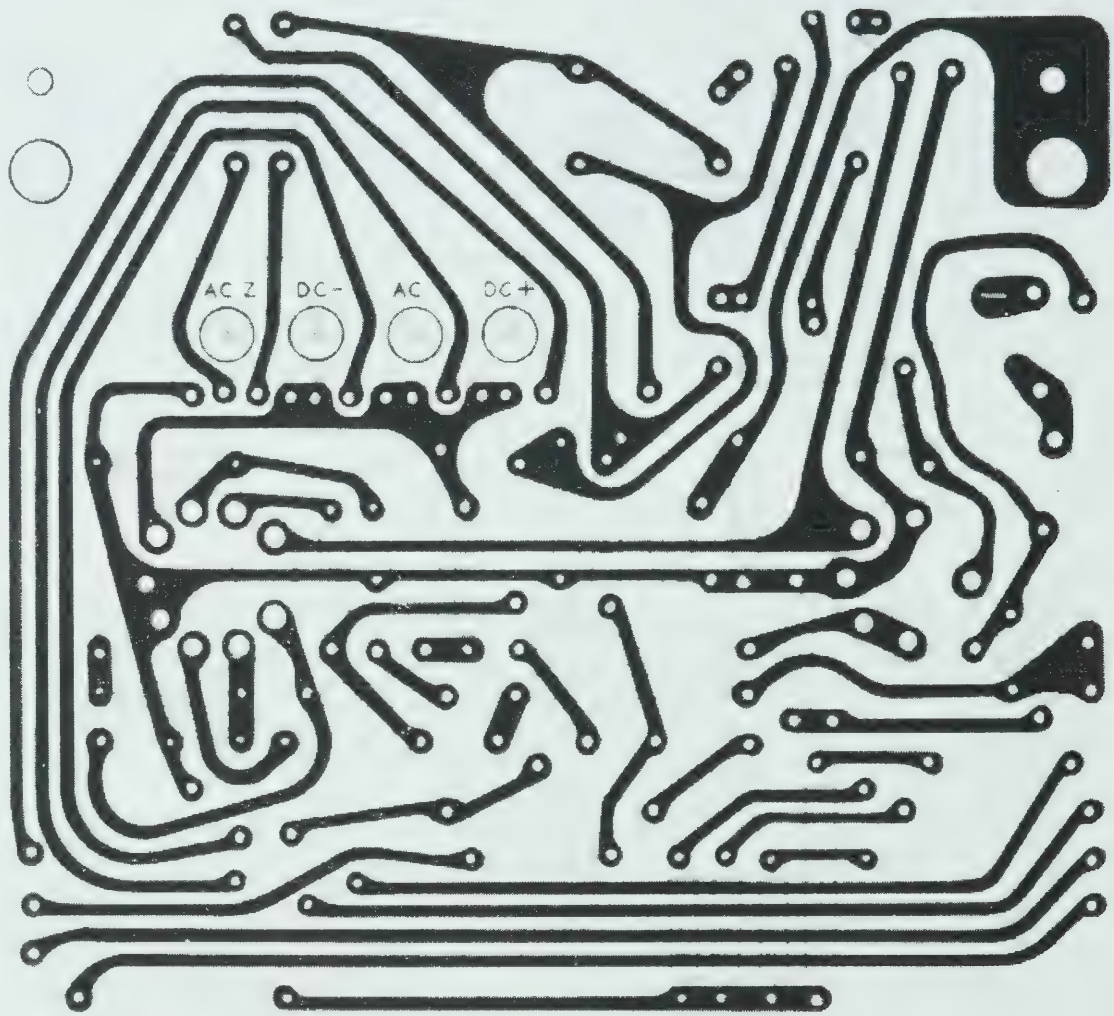


Figure 6. View of foil circuit of laminated board, showing components on opposite side

Note: In instruments with serial numbers between 76001 and 81000, R-35 is mounted on S-2, the range switch.

Replacement Parts List

WV-98C Senior VoltOhmyst

When ordering replacement parts, include the stock number and description of the part, as well as the serial number and code number of instrument. Parts should be ordered through a local RCA tube and parts distributor.

Symbol No.	Description	Stock No.
	Capacitors	
C1	Ceramic, Flat .05 μf, 600V	221435
C2	Ceramic Desc, .02 μf, 500V	99585
C3	Tubular Ceramic, 24 μμf, 500V	221450
C4	Ceramic, Flat, .1 μf, 600V	99321
C5, C7	Ceramic Disc, .01 μf, 450V	73960
C6	Ceramic Disc, .005 μf, 500V	212740
C8	Electrolytic, 10 μf, 200V	218002
C9	Ceramic Tubular, 56 μμf, 500V	54797
	Resistors	
R1	Carbon Film, 150K, ½W, 1%	56483-A
R2	Carbon Film, 324K, ½W, 1%	210105
R3	Carbon Film, 900K, 2W, 1%	59536
R4	Carbon Film, 9.75, 1W, 1%	96613
R5	Carbon Film, 100, ½W, 1%	214882
R6	Carbon Film, 1K, ½W, 1%	215169
R7	Carbon Film, 10K, ½W, 1%	209648
R8	Carbon Film 2.12M, ½W, 1%	94011
R9	Carbon Film, 8.49M, ½W, 1%	94010
R10	Composition, 91M, ½W, 20%	
R11	Carbon Film, or Comp., 16M, ½W, 5%	
R12	Carbon Film, 7M, 1W, 1%	59538
R13	Carbon Film, 2M, ½W, 1%	59540
R14	Carbon Film, 700K, ½W, 1%	59541
R15	Carbon Film, 200K, ½W, 1%	56733
R16	Carbon Film, 70K, ½W, 1%	59542
R17	Carbon Film, 20K, ½W, 1%	213657
R18	Variable, 15K, ¼W, 20%	210100
R19, R20		
R21, R33	Variable, 4-section, 10K, ¼W	221336
R22	Variable, 10K, ¼W, 20%	210101
R23, R24	Carbon Film, or Comp., 10K ½W, 5%	
R25	Composition, 3.3M, ½W, 10%	
R26	Composition, 6.8M, ½W, 10%	
R27, R28	Carbon Film, or Comp., 330, ½W, 5%	
R29	Carbon Film, or Comp., 15K, ½W, 5%	

Symbol No.	Description	Stock No.
R30	Composition, 27K, ½W, 5%	
R31	Composition, 1M, ½W, 10%	
R32	Composition, 47K, ½W, 5%	
R34	Composition, 180K, ½W, 10%	
R35	Variable 10K, ¼W, 20%	224891
R36	Carbon Film, 8.2K, ½W, 5%	
R37	Carbon Film, 1.6K, ½W, 5%	
R38	Carbon Film, 2.4K, ½W, 5%	
R39	Composition, 1K, ½W, 10%	
	Switches	
S1	Switch Rotary (Function) 5 Positions, 3 Sections	224892
S2	Switch Rotary (Range) 8 Positions, 3 Sections	224893
	Miscellaneous	
CR1	Diode, Silicon	235382
T1	Transformer, power, 120V	221337
	Transformer, power, for 120/240V	237611
M1	Meter	241432
J1	Connector, probe, w/hardware	210110
DS1	Lamp, neon	218017
	Board, Laminated Circuit	227872
	Button-plug, for front panel	215831
	Clip, Alligator	35262
	Clip, battery	221436
	Clip, pilot lamp	221343
	Handle, black	210093
	Insulator, black, for alligator clip	99539
	Knob control, blue plastic, w/pointer	212148
	Knob, black rubber	948782
	Meter front, plastic	210287
	Metal case, front	221346
	Metal case, rear	221347
	Panel	224890
	Probe and cable, DC-AC/Ohms	WG-299D
	Socket, tube, 7 pin min	221341
	Socket, tube, 9 pin min	221342
	Stud, handle mounting	221598
	"C" washer	78652
	Washer fibre w/shoulder	221812
	Washer, fibre flat	221813

Special Applications

In addition to maintenance and service applications of the WV-98C in ac, dc, af, and pulsed electronic and electro-mechanical equipment, the instrument may be used with versatility in numerous special applications. The special applications described below will help to illustrate the wide range of usefulness of the instrument.

Oscillator Grid-Bias Measurement. The negative dc voltage developed at the grid of an oscillator tube is proportional to the amplitude of oscillation. The impedance of these circuits is usually high and any test instrument inserted into the oscillator must be of sufficiently high impedance so as not to change appreciably the total value of the circuit impedance. The WV-98C is well suited to measurements of this nature. To measure grid bias, the instrument should be set up on the appropriate dc-voltage range and the switch on the WG-299E Probe set to "DC".

Comparative voltage readings should be taken on each band of a multiband receiver and the main tuning capacitor should be rotated through each band while the bias is being measured.

AGC/AVC Voltage Measurements. The WV-98C can be used to measure age or avc voltage at the diode-load resistor, along the bias buses, or at the grids of the controlled tubes.

Output Indication. The Senior VoltOhmyst is a useful instrument for measuring output in the alignment of radio and television receivers. In these applications, the switch on the WG-299E Probe is set to "DC" and the probe connected to the load resistor of the second detector in AM and TV receivers while the circuit components are adjusted for optimum output. In an FM receiver, the probe is connected to the limiter load resistor. The zero-center feature of the WV-98C is particularly useful in alignment of FM discriminators.

Bias-Cell Voltage Measurements These small voltages can be measured accurately by the WV-98C. The voltage ranges 0 to .5, 0 to 1.5, and 0 to 5 volts provide easy-to-read indications of small voltages, an important feature where bias voltages are critical.

Detection of Gassy Tubes. Gassy tubes frequently may pass the check of an ordinary tube tester but cause improper functioning of equipment in which they are installed. The presence of gas in an output tube or avc-control tube, for example, can impair the function of the entire receiver. In an RC-coupled circuit, the presence of a positive voltage at the grid of a tube usually indicates a gassy tube or a defective coupling capacitor. Check the socket grid-pin voltage with the tube removed. If no positive voltage is present, the tube is probably defective.

Insulation-Resistance Measurements. Current leakage through the dielectric of capacitors and insulation of coils, transformers, cables, and other components can be measured with the WV-98C in terms of resistance. Values of leakage resistance above 1000 megohms can be measured with the circuit shown in Figure 2.

When resistance measurements are made, the probe of the WV-98C is always positive with respect to the ground cable. This arrangement facilitates the measurement of leakage resistance in components such as electrolytic capacitors where polarity must be observed.

DBM Measurements. The graph on page 23 can be used to determine dbm values corresponding to rms ac-voltage values across a 600-ohm resistive load. A dbm value is defined as the number of decibels above or below a reference level of 1 milliwatt in 600 ohms at 1000 cycles. Zero dbm, therefore, would indicate a power level of 1 milliwatt; 10 dbm, 10 milliwatts; and 20 dbm, 100 milliwatts.

The graph makes possible rapid conversion of rms voltages to corresponding dbm values. Associated power levels can be read along the top of the graph. If the rms voltage is measured across a resistive load other than 600 ohms, the correction factors given below must be added algebraically to the dbm values read from the graph in Figure 9. For resistive loads not given in the table, the following formula should be used for determining the correction factor:

$$\text{Correction Factor} = 10 \log \frac{600}{R}$$

where R is the load in ohms. If R is greater than 600 ohms, the correction factor is negative.

Because dbm are defined with respect to a 600-ohm load, power levels correspond to voltage values. DBM can be measured in terms of rms voltages across a 600-ohm resistive load. For example, 0.775 rms volt indicates 0 dbm 7.75 rms volts indicate 20 dbm. While these measurements must be made with a sine waveform to avoid waveform error, any frequency can be used which is within the range of the WV-98C. The decibel and ear-response curves have their closest correlation at 1000 cycles.

Resistive Load at 1000 cps	DBM*
600	0
500	+0.8
300	+3.0
250	+3.8
150	+6.0
50	+10.8
15	+16.0
8	+18.8
3.2	+22.7

* DBM is the increment to be added algebraically to the dbm value read from Figure 9.

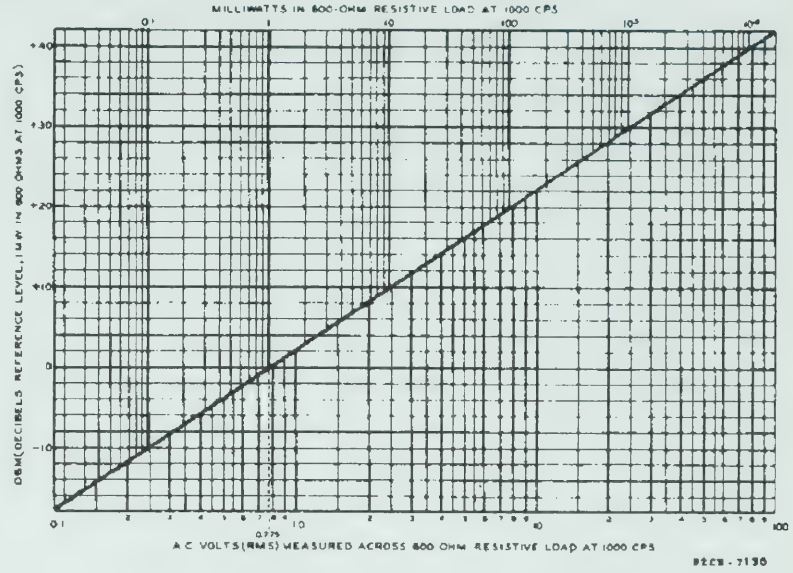


Figure 8. Graph for conversion of rms voltages to dbm values

Accessories

Available on Separate Order

The RCA WG-301A Crystal-Diode Probe may be used with the Senior VoltOhmyst to extend the frequency range to 250 megacycles. This probe consists of a germanium rectifier and an RC network in a polystyrene housing. The probe, which slips onto the front of the WG-299E Probe and Cable, eliminates the need for an extra cable.

The WG-301A may be used in rf circuits to measure sine-wave voltage values up to 20 rms volts in the presence of dc voltage as high as 250 volts. The over-all frequency range of the probe is from 50 Kc to 250 Mc. All rf voltages are read from the dc scales in terms of rms volts for sine waves. For example: A reading of 5 volts dc indicates that the sine wave being measured has an rms value of 5 volts. The all-over accuracy of the WV-98C when used with the WG-301A is ±10%.

The RCA WG-411A Slip-on High Voltage Probe may be used to measure DC voltages as high as 50,000 volts. The probe uses the WG-206 Multiplier Resistor, having a value of 1090 megohms, to present an over-

all voltmeter input resistance of 1100 megohms. With a multiplying factor of 100, the Senior VoltOhmyst provides six full-scale positions of 150, 300, 1500, 3000, 15,000 and 50,000 volts. Do not measure voltages higher than 50,000 volts, because the maximum voltage rating of the probe may be exceeded. The extremely high impedance of the WG-411A is especially desirable when it is necessary to measure voltages found in phototubes, Geiger-Counter tubes, television, and other high-impedance circuits which would not function properly if loaded down by a low-impendance voltmeter.

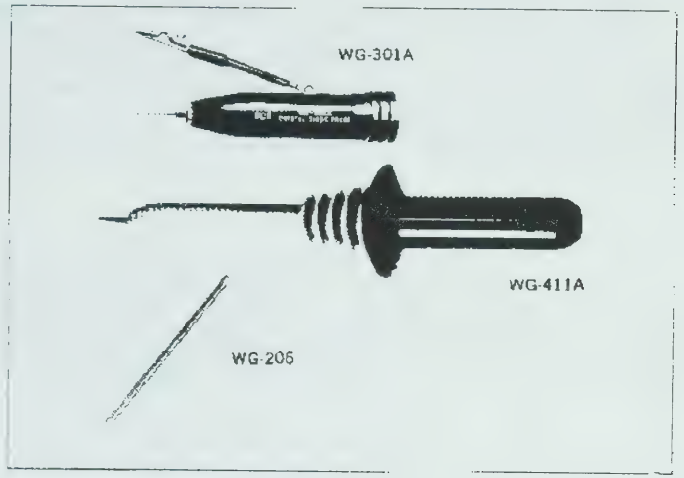


Figure 9. Accessories available on separate order

NOTE: The WG-289 High Voltage Probe and Cable can also be used with the WV-98C. The WG-289 is the same as the WG-411A, except that the cable attaches directly to the panel connector.

Circuit Description

The operation of the Senior VoltOhmyst centers around a vacuum-tube bridge circuit using an RCA 12AU7A twin-triode. (See schematic diagram, page 16.) When this bridge is properly balanced the voltages at the two plates will be equal and the 200-microampere meter, connected between the plates, will read zero.

When a positive voltage is applied to the grid of triode section V2A, the current through the left half of the bridge is increased, causing the voltage at the plate of this section to decrease. This current also flows through the common cathode resistor, increasing the voltage drop across it, and biasing the grid of triode section V2B in a negative direction. This causes a voltage increase at the plate of triode section V2B. The difference in potential across the meter causes current to flow through the meter from the plate of section V2B to the plate of section V2A.

When the WV-98C is used to measure ac voltage, the voltage is first rectified by an RCA-6AL5 twin-diode which serves as a full-wave peak-to-peak rectifier. This tube, shown as V 1 on the schematic diagram, has associated components chosen to give the circuit a long time constant. When the ac signal swings negative, C 1 is charged through the left-hand diode section to the negative peak value of the voltage. As the voltage starts in a positive direction, this diode section becomes nonconducting and the charge on C 1 is prevented from discharging. As the ac signal swings positive, the positive peak is added in series with the charge on C 1 and is applied to the plate of the right-hand diode section. C 2 charges to a value equal to the sum of the positive and negative peaks. Because of the relatively long time constant of the circuit, the voltage across C 2 will be maintained at the peak-to-peak value of the applied ac voltage. A portion of this voltage is then applied as a dc voltage to the grid of triode section V2A of the 12AU7A bridge tube and the circuit action is the same as described above.

When the instrument is set up to measure resistance, ac voltage, or dc voltage, the meter is isolated from the source voltage by the 12AU7A bridge tube, as shown in the schematic diagram. This current limitation provided by the 12AU7A and its associated components decreases the danger of overloading the meter.

Maintenance

(See "Safety Precautions", page 4)

The WV-98C Senior VoltOhmyst is manufactured, tested, and calibrated under strict engineering supervision. If the instrument should require adjustment or repairs, the procedures outlined below should be followed.

The schematic diagram of the WV-98C is shown in Figure 5. If it becomes necessary to replace any of the component parts, only RCA replacement parts or their equivalents should be used. Replacement parts should be ordered from a local RCA tube and parts distributor and the code and serial numbers of the instrument, as well as the stock number of the replacement parts, should be specified in the order. Stock numbers and descriptions should be obtained from the Replacement Parts List on page 20.

Mechanical Zero Adjustment:

The meter pointer should rest at the left-hand zero mark when the function selector is turned to the "OFF" position. If the pointer should come to rest at a deflected position, the position may be corrected mechanically as follows:

1. Remove the meter-adjustment hole cover.

CAUTION: Extreme care must be taken in the next step to prevent insertion of the tool to a depth which will injure the pointer spring. The meter warranty does not cover such damage.

2. Insert a scriber or similar tool to engage the zero-adjustment lever, and move the lever laterally as required to bring the pointer to "0".

3. Replace the meter-adjustment plug.

Electrical Balance Check:

1. Set the function selector to "+DC VOLTS" and allow the WV-98C to warm up for 15 minutes.

2. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 60% of full-scale deflection on any range.

3. Set the SELECTOR control to "− DC VOLTS".

4. Rotate the ZERO ADJ control. It should be possible to set the meter pointer at either zero or 10% of full-scale deflection on any range.

5. If the conditions given in steps 2 and 4 above cannot be satisfied, there is an unbalance between the two triode sections of the 12AU7A bridge tube and it should be replaced. See the section on Tube Replacement below.

Calibration

The calibrating controls are located on the rear of the laminated circuit board. Each control is marked as to its function.

The calibration of the WV-98C should be checked after any internal adjustments are made or after any of the component parts are replaced. If recalibration is necessary, the instrument should first be recalibrated on dc voltage as follows:

NOTE: The accuracy of calibration cannot exceed the accuracy of the standards employed.

DC-Voltage Calibration:

1. Check the mechanical zero position of the pointer. If necessary, zero the pointer as described above.

2. Turn the function selector to "−DC VOLTS" and allow the WV-98C to warm up for at least 30 minutes.

3. Check the line voltage. The WV-98C should be calibrated with the power cord connected to a 120 volt, 60 cycle line source.

4. Rotate the ZERO ADJ control to bring the pointer exactly to zero.

5. Set the range switch at "50V".

6. Connect the Ground Cable clip to the negative terminal of a dc voltage source supplying exactly 50 volts. The switch on the WG-299E should be set to "DC". Connect the probe to the positive terminal of the source voltage.

7. With a screwdriver, adjust the "+DC CAL" potentiometer, R19 to bring the pointer exactly to the full-scale "5.0" mark on the 0 to 5.0 DC scale.

8. Reverse the test lead connections at the voltage source.

9. Set the function selector to "−VOLTS".

10. With a screwdriver, adjust the "DC−" potentiometer R20 to bring the pointer exactly to the 50-volt mark on the scale.

11. Check the 1.5V, 5V, 15V, 150V, 500V, and 1500V dc ranges against other dc sources of known accuracy which provide full-scale deflection.

12. Set the range switch to the ".5V DC" position. Touch the probe tip to the ground clip and re-set the ZERO ADJ control so that the meter pointer rests on "0".

13. Connect the probe and ground clip to a dc voltage source supplying exactly .5 volts.

14. With a screwdriver, adjust potentiometer R-35 to bring the meter pointer to the full-scale "5.0" mark on the 0 to 5.0 DC scale.

AC-Voltage Calibration:

To calibrate for ac voltage, proceed as follows:

1. Set the switch on the WG-299E to "AC-OHMS".
2. Set the function selector to "AC VOLTS".
3. Set the range selector to "1.5 VOLTS".
4. Short the WG-299E probe to the ground clip and adjust the "AC Z" potentiometer, R33 so that the pointer rests exactly at zero. If a zero meter reading cannot be obtained, replace the 6AL5. See "Tube Replacement", below.
5. Set the range control to "50V".
6. Apply 50 volts, 60 cps between the ground lead and the tip of the probe. The meter reading should be within ±3%. If the accuracy is not within this figure, adjust the "AC" control, R21, to give full scale deflection of the meter pointer.

Ohms Adjustment

NOTE: The battery must be installed for all resistance measurements.

1. Set the function selector to "−VOLTS" and make certain the pointer is at zero.
2. Turn the function selector to the "OHMS" position.
3. Set the range control to "RX1".
4. Adjust the OHMS ADJ control for full-scale deflection.
5. Turn the range switch to the "RXIMEG" position. The meter pointer should read above 1000 on the resistance scale. If the pointer indicates a lower value, there is excessive leakage in the ohmmeter circuit.

If it is necessary to readjust the OHMS ADJ control when changing from a low-range position to the "RXIMEG" position, refer to the section on Tube Replacement below. If it is impossible to obtain full-scale setting of the pointer with the OHMS ADJ control and correct ac and dc voltage readings can be obtained, the battery should be replaced.

Tube Replacement

All tubes supplied originally with WV-98C have been thoroughly aged by operating them for several hours before installation in the instrument. This preliminary conditioning of a new tube helps to insure stability and dependable performance.

If a new tube is installed without prior aging, it may be necessary to rezero the instrument when it is switched from the lowest to the highest dc-voltage range. This operating inconvenience may be corrected by aging the tube as follows.

A suggested preaging method for the 12AU7A is to operate the plates at 115 volts dc with the grids and cathodes connected to the B− source. Heaters should be operated at 6.3 volts, 60 cps. The tube should be aged

for approximately 12 hours before it is installed in the instrument. The calibration should then be checked.

An alternate, and usually satisfactory, aging procedure consists of operating the new tube in the WV-98C for approximately 36 hours, after which time the instrument may be recalibrated. If this procedure is unsatisfactory, the first aging procedure should be followed.

If it becomes necessary to replace the 6AL5, the tube can be aged for a minimum period of 36 hours by operating it in the instrument. After this period of time, the calibration should be checked according to the procedure outlined under "AC Calibration Check".

Battery Testing

CAUTION: Do not allow exhausted cells to remain inside the case of the WV-98C as chemicals from deteriorated cells may damage the instrument.

The battery should be tested frequently to insure accuracy of resistance measurements. It may be tested as follows.

1. Turn function selector to "OHMS".
2. Set range control to "RX1" position.
3. Rotate the OHMS ADJ control to bring the pointer to full-scale deflection.
4. Short the Ohms Cable to the Ground Cable for about 10 seconds.
5. Open the short circuit and observe the scale indication. Any appreciable deviation from full-scale deflection indicates weak cells which should be replaced.

RCA Repair Service

RCA maintains a complete repair service for the adjustment, calibration and maintenance of RCA test equipment. If it becomes necessary to service this equipment, fill out one of the Test Equipment Service order forms supplied with the instrument. It is important that:

1. Test equipment be packed carefully. The instrument should be double-packed. It is best to pack the unit in its original carton, or similar container, then "float" this carton in at least a 3-inch layer of shredded paper inside the outer carton.
2. A full description of the trouble be included in the report.
3. All probes, cables, and test leads used with the equipment be included in the shipment.

Attention to these details will help prevent damage in transit and delay in repairs.

Instructions for RCA WV-98CX (Export Model)

Transformer Hookup

Remove the case from the unit by taking out the four screws on the back. For convenient access to the transformer wires, remove the meter from the case-front. The meter is attached with four hex nuts on the back of case-front. It is not necessary to disconnect the wires to the meter terminals.

120 Volt, 50-60 cps Operation

1. Insert both the black and the black-white wires from T-1 in the circuit board hole marked "BLK". (S)

2. Insert both the red-black and the black-yellow wires in the hole marked "RED-BLK". (S)

3. Insert the power cord lead in hole 2. (S)

240 Volt, 50-60 cps Operation

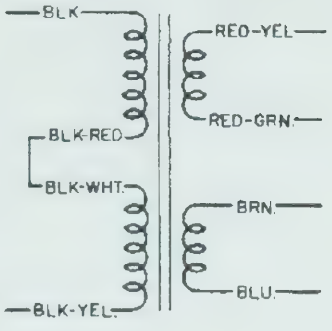
1. Insert the black wire from T-1 in the circuit board hole marked "BLK". (S)

2. Insert the red-black wire in the hole marked "RED-BLK". (S)

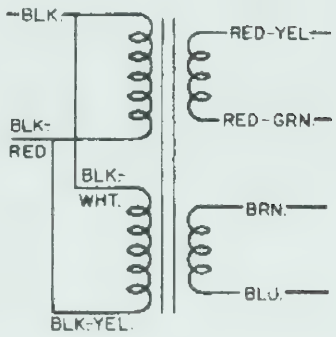
3. Remove power cord lead from hole 2 and connect it to the black-yellow lead from T-1. Twist the ends of these leads together, solder the connection, and cover with electrical insulating tape.

4. Insert the black-white lead in hole 2. (S)

FOR 240 VOLT OPERATION



FOR 120 VOLT OPERATION



WG-299D, WG-300B, WG-301A, WG-302A PROBES AND CABLES

This bulletin describes two probes and cables and two accessory slip-on probes for use with various RCA VoltOhmysts* and Oscilloscopes. They are as follows: WG-299D DC/AC-Ohms Probe and Cable and the WG-301A Crystal-Diode Probe for VoltOhmysts, and the WG-300B Direct/Low-Capacitance Probe and Cable and the WG-302A RF-IF-VF Signal-Tracing Probe for oscilloscopes.

WG-299D DC/AC - Ohms Probe and Cable

Note: The WG-299D Probe and Cable replaces the earlier models WG-299 A,B,C. However, all four types can be used interchangeably.

The WG-299D is a sturdy, sealed probe and cable designed for and supplied with the RCA series WV-87 and WV-98 VoltOhmysts. This probe can be used for measuring either resistance or AC and DC voltage. The build-in fingertip switch on the WG-299D provides instant selection of either the "DC" or the "AC/OHMS" function. An accessory Crystal Diode Probe, WG-301A, is available for use in conjunction with the WG-299D.

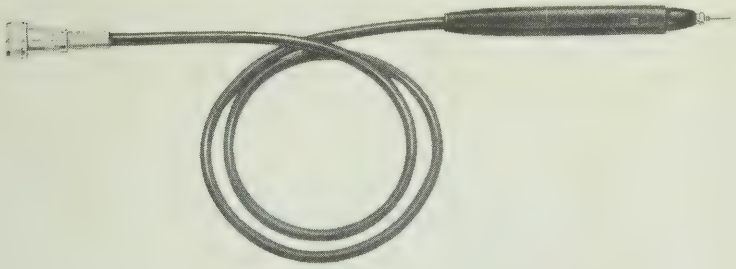


Figure 1. WG-299D DC/AC-Ohms Probe and Cable.

When the sliding switch on the WG-299D is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the VoltOhmyst. This resistor acts to isolate the instrument from the circuit under test and is part of the overall input resistance of the voltmeter. The switch should always be set to the "DC" position for dc-voltage measurements.

When the sliding switch is set to the rear or "AC-OHMS" position, the isolating resistor is shorted out to connect the probe tip directly to the input of the voltmeter. The switch should always be set to the "AC-OHMS" position when resistance or ac-voltage measurements are made and when the accessory WG-301A Crystal-Diode Probe is used.

* Trade Mark "VoltOhmyst" Reg. U.S. Pat. Off.

1 The WG-299D may be used with the WV-77A and WV-77B as a replacement for the probe and cable supplied with this instrument. The WG-299D may also be used with models number WV-87A, WV-97A, 170, 170A, 195, and 195A for dc and ac measurements. These models do not require the "ohms" function of the probe because they are supplied with a separate ohms probe and cable. The WG-299D cannot be used with 165 and 165A Junior VoltOhmysts.

WG-301A Crystal-Diode Probe

The RCA WG-301A Crystal-Diode Probe is a slip-on accessory for use with the WG-299D for measurements of sine waves at frequencies up to 250 Mc.

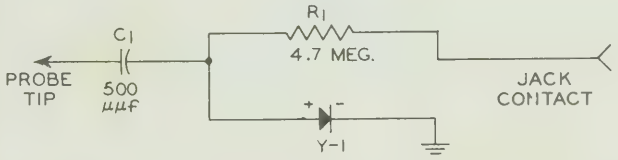


Figure 2. Schematic Diagram of WG-301A.

The WG-301A probe contains a crystal diode, which functions as a half-wave rectifier, and an rf filter, as shown in Figure 2. The circuit develops a dc output voltage proportional to the peak value of a sinusoidal waveform.

When the WG-301A is used with a VoltOhmyst, the rms value of the sine wave is read from the dc-voltage scales of the instrument. For example: A reading of 5 volts dc indicates that the sine wave being measured has an rms value of 5 volts. The peak value of this voltage may be obtained by multiplying the 5-volt meter reading by 1.41. The probe may be used in circuits having dc voltages up to 250 volts and where the ac voltages do not exceed 20 rms volts or 28 peak volts.

OPERATION

To use the WG-301A Crystal-Diode Probe with a VoltOhmyst, slip the probe onto the front end of the WG-299D. Set the DC/AC-OHMS switch to the "AC-OHMS" position.

Turn on the instrument and set the SELECTOR switch to the "-DC" position. Set the RANGE switch to the desired dc-voltage range. Connect the ground clip of the WG-301A probe to the ground or negative side of the voltage source to be measured and touch the probe tip to the positive side of the voltage source. CAUTION: See "Maximum Input" in the specifications below. The rms value of the sine wave should be read from the dc-voltage scale selected by the RANGE switch.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION, HARRISON, N. J.
(TEST EQUIPMENT, CAMDEN, N. J.)

TMK ®, Marca Registrada

WG-299D, 300B, 301A, 302A 2-60
Printed in U.S.A.

WG-300B Direct/Low-Capacitance Probe & Cable

NOTE: The types WG-300A and WG-300B probes and cables differ in their internal construction and electrical characteristics. Although their application is the same, it is not recommended that they be used interchangeably. The WG-300A contains a built-in trimmer capacitor which can

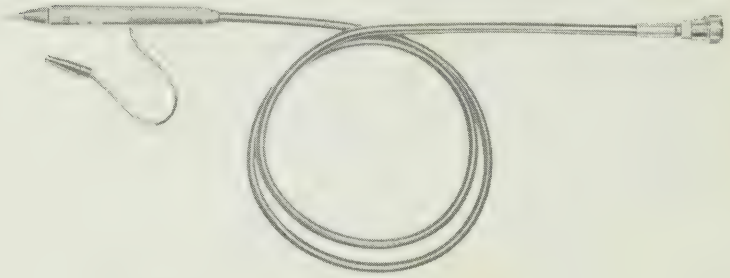


Figure 3. WG-300B Direct/Low-Capacitance Probe and Cable.

be adjusted as described below to match the input characteristics of the oscilloscope. The WG-300B, however, utilizes a fixed capacitor in the probe, and compensation is made by means of a small trimmer capacitor in the oscilloscope.

The WG-300B is designed for use with RCA models WO-56A, WO-78A, WO-78B, WO-88A, and WO-91A oscilloscopes which are especially equipped with trimmer capacitors in the vertical-input circuits to permit compensating for the capacitance of the WG-300B probe and cable. Not all of these scopes contain this trimmer capacitor. The capacitor (5-25 $\mu\mu$f, RCA Replacement Parts Stock No. 204811) may be

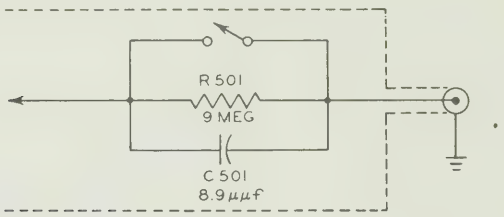


Figure 4. Schematic Diagram of WG-300B.

added to the scopes as described below. The adjustment of the trimmer in all scopes is the same, as described under "Adjustment of the WG-300B".

WO-56A -- Connect a 5-25 $\mu\mu$f ceramic trimmer capacitor under the chassis from the V INPUT connector lead to the ground lug on the terminal board located behind the GND terminal. If necessary, add a short length of stiff wire between the capacitor and the ground lug.

WO-78A -- Add a solder lug under the GND terminal on the underside of the chassis and connect a 5-25 $\mu\mu$f ceramic trimmer capacitor from the V INPUT lead to the new ground lug. If necessary, add a short length of stiff wire between the capacitor and the ground lug.

WO-88A -- Remove the vertical metal shield alongside the input-attenuator switch and drill a hole for a 6-32 screw in the shield. Mount the screw, washer, nut, and ground lug on the shield and reinstall in the scope. Connect a 5-25 $\mu\mu$f ceramic trimmer capacitor from the V INPUT lead to the new ground lug.

WO-91A -- NOTE: Some WO-91A instruments having Code No. 655 are equipped with a 1.5-7 $\mu\mu$f ceramic trimmer capacitor which may not provide a sufficient range of adjustment to accommodate the WG-300B. If the WG-300B cannot be compensated for by means of this capacitor, replace it with a 5-25 $\mu\mu$f ceramic trimmer. In WO-91A instruments which are not equipped with a capacitor, connect a 5-25 $\mu\mu$f ceramic trimmer across the two lugs of the terminal board in back of the V INPUT connector.

Adjustment of the WG-300B

Adjustment of the oscilloscope trimmer capacitor for the WG-300B probe and cable requires use of a square-wave generator. Procedure is as follows:

1. Apply power to the scope and the square-wave generator. Set the input-attenuator switch on the scope to its most sensitive position.

2. Tune the generator to deliver a 10-kc square wave.

3. Set the sliding switch on the WG-300B to the "DIRECT" position. Adjust the scope sweep and sync controls and the scope gain and generator output control to produce two locked-in waveforms approximately two inches high on the screen.

4. Set the sliding switch to "LOW CAP" and increase the generator output to produce the same amplitude as observed in step 3.

5. Adjust the trimmer capacitor in the scope to produce a square wave of the same shape as observed in step 3.

When the switch on the WG-300B is set to the "Direct" position, the test signal is fed directly to the vertical-input terminal of the oscilloscope. When the switch is set to the "LOW CAP x 10" position a built-in high-impedance network is connected in series with the test point and the probe cable. This network permits measurements in high-impedance circuits, such as those found in TV-sync-separator and video-amplifier stages, which would not operate properly if loaded down by a conventional probe and cable.

When the probe is used in its low-capacitance position, the input capacitance of the instrument is reduced to approximately 11 $\mu\mu$f and the input resistance is raised to 11 megohms. (See Figure 4.) This high input resistance attenuates the signal by a factor of ten. Therefore, the

indicated voltage should be multiplied by 10 to obtain the actual value.

Adjustment of the WG-300A

The WG-300A is provided with a trimmer capacitor to permit adjustment of the square-wave response. The adjustment procedure is as follows:

1. With the WG-300A connected to the vertical input terminal of the oscilloscope, set the probe switch to "LOW CAP".

2. Obtain a trace of a clean horizontal-sync pulse from a television receiver by connecting the oscilloscope across the second detector load. A square-wave generator set to 1000 cps may be used instead of the sync pulse.

3. Loosen the threaded nut on the tip of the probe. Slowly rotate the probe tip for the best square-wave pattern on the oscilloscope screen. Tighten the nut.

NOTE: On WO-78A oscilloscopes it may be necessary to add a small trimmer capacitor (3-12 μμf) inside the instrument to compensate for the effects of the WG-300A Probe and Cable. Connect the trimmer from the V INPUT terminal to the nearest ground point. The capacitor should be added to all WO-56A oscilloscopes.

WG-302A RF-IF-VF Signal-Tracing Probe

The WG-302A RF-IF-VF Signal-Tracing Probe is a slip-on accessory for use with the WG-300A and WG-300B for signal tracing. The accessory probe contains a crystal diode and an rf filter housed in a plastic case. When the WG-302A is used, the switch on the WG-300 should be set to the "Direct" position.

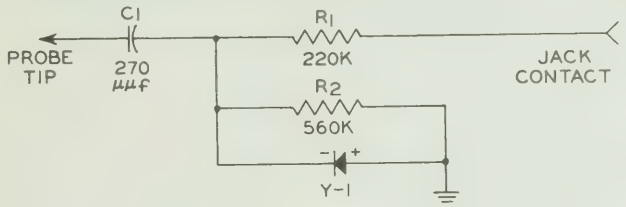


Figure 5. Schematic Diagram of WG-302A.

The time-constant of the rectifier circuit in such that when the WG-302A is used in high-frequency circuits, the low-frequency modulation is separated from the amplitude-modulated rf carrier. The low-frequency component is then fed to the input of the oscilloscope through the WG-300A or WG-300B. The waveform is centered vertically on the zero axis of the screen when an ac RC-coupled oscilloscope is used. When a direct-coupled oscilloscope is used, the waveform is displaced vertically a distance proportional to the dc voltage resulting from the rectification of the rf carrier.

When the WG-302A is used with an oscilloscope such as the WO-91A and a sweep generator is employed to sweep the picture or sound if amplifier of a television receiver, it is possible to observe the response characteristic of individual amplifier stages without upsetting the performance of the high-frequency stage. With this combination of equipment, it is possible to observe the re-

SPECIFICATIONS

	WG-299A WG-299B WG-299C WG-299D *(For use with models WV-77A, WV-77B, WV-77C, WV-87A#, WV-87B, WV-97A#, WV-98A, 195 and 195A VoltOhmysts and models 170 and 170A Chanalysts and similar instruments.)*		WG-300A WG-300B *(For use with models WO-56A, WO-78A, WO-78B, WO-88A, WO-91A, and similar oscilloscopes.)*		WG-301A *(For use with WG-299A, WG-299B, and WG-299C probes and cables.)*	WG-302A *(For use with WG-300A and WG-300B probes and cables.)*
	"DC" OPERATION	"AC-OHMS" OPERATION	"DIRECT" OPERATION	"LOW CAP" OPERATION		
INPUT FREQUENCY RESPONSE RANGE	*	30 cps to 3 Mc across 100-ohm source	*	Flat to 10 Mc (Probe and cable only)	±0.75 db 50 Kc to 250 Mc	±1 db 100 Kc to 250 Mc
INPUT RESISTANCE	11 megohms total with VoltOhmyst)	Depends upon VoltOhmyst	1 megohm (Scope Input Resistance)	10 megohm (with 'scope)	*	*
INPUT CAPACITANCE	Less than 4 μμf	Depends upon VoltOhmyst	Less than 100 μμf	Less than 13 μμf	Less than 3 μμf	Less than 3.75 μμf
MAXIMUM INPUT VOLTAGE DC	1500V	Combined dc and ac peak = 2000V	600V	600V	250V	250V
MAXIMUM INPUT VOLTAGE AC	1000V rms	1500V rms (sine wave)	600V peak-to-peak	600V peak-to-peak	20V rms	20V rms
DEMODULATION RANGE	*	*	*	*	*	30 to 2000 cps

* Does not apply

Has separate ohms cable. WG-299 used only for AC & DC functions.

sponse curves of picture and sound if amplifiers, video amplifiers, tuners, and overall response curves in all high-frequency sections of the television receiver.

An input capacitance of only 3 $\mu\mu$f for the probe permits its use in these critical circuits and without seriously detuning the amplifiers. Because the capacitance of the WG-302A is less than that of the kinescope grid circuit, the probe may also be connected to the output of the video amplifier with negligible effect on the circuit.

The WG-302A extends the range of the oscilloscope of 50 Mc. This range covers the if and video frequency sections of television receivers. The connection of a short ground lead between the probe and the low side of the circuit under test will extend the usable range of 250 Mc for signal tracing in tuners. To add the ground lead, remove the nylon screw in the body of the case, and connect a 3-inch ground lead by means of a metal screw. Insulate the screw head.

The WG-302A RF-IF-VF Signal-Tracing Probe is designed to be used as an indicating device rather than a voltage-measuring instrument. If the WG-302A is used for voltage measurments, the probe and the oscilloscope can be calibrated against a known voltage.

Replacement Parts Lists

When ordering replacement parts, include the stock number and description of the part, as well as the type number of the probe. Parts should be ordered through a local RCA tube and parts distributor.

SYMBOL No.	DESCRIPTION	STOCK No.
	WG-299A DC/AC Ohms Probe and Cable	
	Probe sub-assembly - Consisting of the following parts: - Probe shell, shield, bushing and insulator, probe tip, switch and 1 megohm resistor....	211400
	Bushing - Probe tip bushing.....	210196
	Shell - Front molding.....	210195
	Shell - Rear molding, blue.....	210202
	Spring : Probe tip bushing tension spring.....	210197
	Connector - Cable, female.....	203574
	Connector - Cable internal connector..	210190
	WG-299B DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing.....	212161
	Connector: internal, brass for cable...	210190-A
	Connector, cable: female, with set screw.....	203574
	Shell: front end, blue.....	210195
	Shell: middle section, with shield, bushing, and insulator.....	212159
	Shell: rear section, blue.....	210202-A
	Spring, coil: for front end.....	210197
	Spring, switch: with insulator.....	212162
	Tip, probe: with switch slide and 1-meg. resistor.....	212160
	Washer, tip:.....	212163
	WG-299C DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing.....	213257
	Connector: internal, brass, for cable.	210190-A
	Connector, cable: female with set screw.....	203574
	Shell: front end, blue.....	210195-A
	Shell: middle section, with shield, bushing, and insulator.....	213664
	Shell: rear section, blue.....	210202-A
	Spring, coil: for front end.....	210197
	Spring, switch: with insulator.....	213665
	Tip, probe; with switch slide and 1-meg. resistor.....	212160
	Washer, tip:	213271
	WG-299D DC/AC-OHMS probe and cable sealed unit, cannot be disassembled.	
	WG-300A Direct/Low-Capacitance Probe and Cable	
	Bushing: for probe tip.....	210196
	Clip: alligator clip.....	210207
	Connector: probe cable internal connector (rear).....	210201
	Insulator: alligator clip cover.....	210209
	Insulator: probe insulator and bushing with Buss wire and lug terminal.....	211691
	Ring: probe ground ring.....	210205
	Shell: center, includes 2 shields, bushing and insulator.....	211688
	Shell: probe, tip molding, blue.....	210195
	Shell: probe, end molding, blue.....	210202
	Spring: guard spring for cable.....	210208
	Spring: for probe tip.....	210197
	Switch: probe switch slide and spring.	211690
	Tip: probe tip and resistor.....	211689
	WG-300B Direct/Low-Capacitance Probe and Cable	
	Bushing, probe tip: for front end.....	213257
	Clip: for grounding lead.....	210207
	Connector, cable: internal, brass.....	213260
	Connector, cable: female, with set screw	203574
	Insulator, clip.....	210209
	Ring, ground: for center section.....	213262
	Shell: for front section, polystyrene, blue.....	212161
	Shell: for center section, polystyrene, blue, with bushing, insulator, and two shields.....	213256
	Shell: for rear section, polystrene, blue.....	213261
	Spring; coil: for front end.....	210197
	Spring, switch: with insulation and insulator.....	213259
	Tip: silver plated, with switch slide, 1-meg resistor, and capacitor....	213258
	Washer: for probe tip.....	213271
	WG-301A Crystal-Diode Probe	
C1	Capacitor: silver mica 500 $\mu\mu$f ± 5%...	95503
R1	Resistor: carbon film, 4.7 meg. ± 1%, 1/2 w.....	213362
Y1	Crystal: crystal diode.....	54374
	Clip: alligator clip.....	210207
	Insulator & Jack Contact Assembly.....	211374
	Lead: unshielded, black, with alligator clip and terminal.....	211379
	Nut: clip lead nut.....	211378
	Screw: clip lead screw.....	211377
	Shell: probe housing blue.....	211372
	Spring: probe contact spring.....	211373
	Tip: probe.....	211375
	WG-302A RF-IF-VF Signal-Tracing Probe	
C1	Capacitor: silver mica, 270 $\mu\mu$f ± 10%.	95504
R1	Resistor: composition, 220,000 ohm ± 10%, 1/2 w.....	502422
R2	Resistor: composition, 560,000 ohm ± 10%, 1/2 w.....	502456
Y1	Crystal: crystal diode.....	54374
	Clip: alligator clip.....	210207
	Insulator & Jack Contact Assembly.....	211374
	Lead: unshielded, black, with alligator clip and terminal.....	211379
	Nut: clip lead nut.....	211378
	Screw: clip lead screw.....	211377
	Shell: probe housing vlue.....	211380
	Spring: probe contact spring.....	211373
	Tip: probe.....	211375

WG-299D, WG-300B, WG-301A, WG-302A
PROBES AND CABLES

This bulletin describes two probes and cables and two accessory slip-on probes for use with various RCA VoltOhmysts* and Oscilloscopes. They are as follows: WG-299D DC/AC-Ohms Probe and Cable and the WG-301A Crystal-Diode Probe for VoltOhmysts, and the WG-300B Direct/Low-Capacitance Probe and Cable and the WG-302A RF-IF-VF Signal-Tracing Probe for oscilloscopes.

WG-299D DC/AC - Ohms Probe and Cable

Note: The WG-299D Probe and Cable replaces the earlier models WG-299 A,B,C. However, all four types can be used interchangeably.

The WG-299D is a sturdy, sealed probe and cable designed for and supplied with the RCA series WV-87 and WV-98 VoltOhmysts. This probe can be used for measuring either resistance or AC and DC voltage. The build-in fingertip switch on the WG-299D provides instant selection of either the "DC" or the "AC/OHMS" function. An accessory Crystal Diode Probe, WG-301A, is available for use in conjunction with the WG-299D.

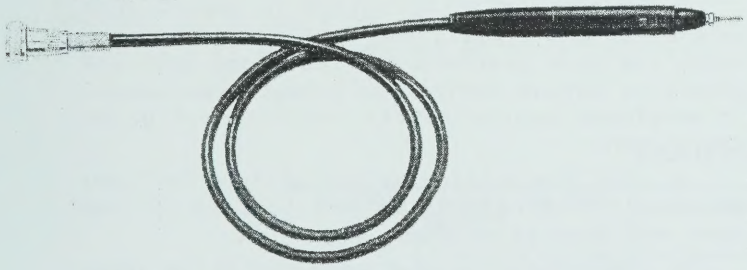


Figure 1. WG-299D DC/AC-Ohms Probe and Cable.

When the sliding switch on the WG-299D is set forward to the "DC" position, a built-in 1-megohm resistor is placed in series with the probe tip and the input to the VoltOhmyst. This resistor acts to isolate the instrument from the circuit under test and is part of the overall input resistance of the voltmeter. The switch should always be set to the "DC" position for dc-voltage measurements.

When the sliding switch is set to the rear or "AC-OHMS" position, the isolating resistor is shorted out to connect the probe tip directly to the input of the voltmeter. The switch should always be set to the "AC-OHMS" position when resistance or ac-voltage measurements are made and when the accessory WG-301A Crystal-Diode Probe is used.

WG-301A Crystal-Diode Probe

The RCA WG-301A Crystal-Diode Probe is a slip-on accessory for use with the WG-299D for measurements of sine waves at frequencies up to 250 Mc.

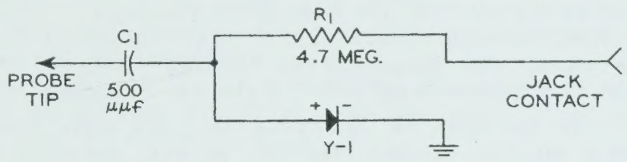


Figure 2. Schematic Diagram of WG-301A.

The WG-301A probe contains a crystal diode, which functions as a half-wave rectifier, and an rf filter, as shown in Figure 2. The circuit develops a dc output voltage proportional to the peak value of a sinusoidal waveform.

When the WG-301A is used with a VoltOhmyst, the rms value of the sine wave is read from the dc-voltage scales of the instrument. For example: A reading of 5 volts dc indicates that the sine wave being measured has an rms value of 5 volts. The peak value of this voltage may be obtained by multiplying the 5-volt meter reading by 1.41. The probe may be used in circuits having dc voltages up to 250 volts and where the ac voltages do not exceed 20 rms volts or 28 peak volts.

OPERATION

To use the WG-301A Crystal-Diode Probe with a VoltOhmyst, slip the probe onto the front end of the WG-299D. Set the DC/AC-OHMS switch to the "AC-OHMS" position.

Turn on the instrument and set the SELECTOR switch to the "-DC" position. Set the RANGE switch to the desired dc-voltage range. Connect the ground clip of the WG-301A probe to the ground or negative side of the voltage source to be measured and touch the probe tip to the positive side of the voltage source. CAUTION: See "Maximum Input" in the specifications below. The rms value of the sine wave should be read from the dc-voltage scale selected by the RANGE switch.

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* Trade Mark "VoltOhmyst" Reg. U.S. Pat. Off.

[1] The WG-299D may be used with the WV-77A and WV-77B as a replacement for the probe and cable supplied with this instrument. The WG-299D may also be used with models number WV-87A, WV-97A, 170, 170A, 195, and 195A for dc and ac measurements. These models do not require the "ohms" function of the probe because they are supplied with a separate ohms probe and cable. The WG-299D cannot be used with 165 and 165A Junior VoltOhmysts.

RADIO CORPORATION OF AMERICA
ELECTRON TUBE DIVISION, HARRISON, N. J.
(TEST EQUIPMENT, CAMDEN, N. J.)

TMK ®, Marca Registrada

WG-299D, 300B, 301A, 302A 2-60
Printed in U.S.A.

WG-300B Direct/Low-Capacitance Probe & Cable

NOTE: The types WG-300A and WG-300B probes and cables differ in their internal construction and electrical characteristics. Although their application is the same, it is not recommended that they be used interchangeably. The WG-300A contains a built-in trimmer capacitor which can

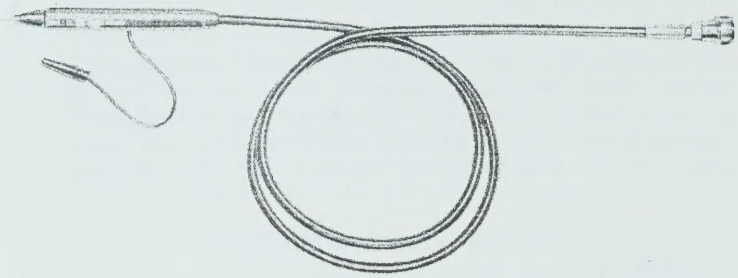

Figure 3. WG-300B Direct/Low-Capacitance Probe and Cable.

be adjusted as described below to match the input characteristics of the oscilloscope. The WG-300B, however, utilizes a fixed capacitor in the probe, and compensation is made by means of a small trimmer capacitor in the oscilloscope.

The WG-300B is designed for use with RCA models WO-56A, WO-78A, WO-78B, WO-88A, and WO-91A oscilloscopes which are especially equipped with trimmer capacitors in the vertical-input circuits to permit compensating for the capacitance of the WG-300B probe and cable. Not all of these scopes contain this trimmer capacitor. The capacitor (5-25 $\mu\mu$f, RCA Replacement Parts Stock No. 204811) may be

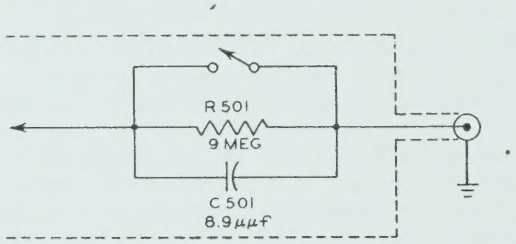

Figure 4. Schematic Diagram of WG-300B.

added to the scopes as described below. The adjustment of the trimmer in all scopes is the same, as described under "Adjustment of the WG-300B".

WO-56A -- Connect a 5-25 $\mu\mu$f ceramic trimmer capacitor under the chassis from the V INPUT connector lead to the ground lug on the terminal board located behind the GND terminal. If necessary, add a short length of stiff wire between the capacitor and the ground lug.

WO-78A -- Add a solder lug under the GND terminal on the underside of the chassis and connect a 5-25 $\mu\mu$f ceramic trimmer capacitor from the V INPUT lead to the new ground lug. If necessary, add a short length of stiff wire between the capacitor and the ground lug.

WO-88A -- Remove the vertical metal shield alongside the input-attenuator switch and drill a hole for a 6-32 screw in the shield. Mount the screw, washer, nut, and ground lug on the shield and reinstall in the scope. Connect a 5-25 $\mu\mu$f ceramic trimmer capacitor from the V INPUT lead to the new ground lug.

WO-91A -- NOTE: Some WO-91A instruments having Code No. 655 are equipped with a 1.5-7 $\mu\mu$f ceramic trimmer capacitor which may not provide a sufficient range of adjustment to accommodate the WG-300B. If the WG-300B cannot be compensated for by means of this capacitor, replace it with a 5-25 $\mu\mu$f ceramic trimmer. In WO-91A instruments which are not equipped with a capacitor, connect a 5-25 $\mu\mu$f ceramic trimmer across the two lugs of the terminal board in back of the V INPUT connector.

Adjustment of the WG-300B

Adjustment of the oscilloscope trimmer capacitor for the WG-300B probe and cable requires use of a square-wave generator. Procedure is as follows:

1. Apply power to the scope and the square-wave generator. Set the input-attenuator switch on the scope to its most sensitive position.

2. Tune the generator to deliver a 10-kc square wave.

3. Set the sliding switch on the WG-300B to the "DIRECT" position. Adjust the scope sweep and sync controls and the scope gain and generator output control to produce two locked-in waveforms approximately two inches high on the screen.

4. Set the sliding switch to "LOW CAP" and increase the generator output to produce the same amplitude as observed in step 3.

5. Adjust the trimmer capacitor in the scope to produce a square wave of the same shape as observed in step 3.

When the switch on the WG-300B is set to the "Direct" position, the test signal is fed directly to the vertical-input terminal of the oscilloscope. When the switch is set to the "LOW CAP x 10" position a built-in high-impedance network is connected in series with the test point and the probe cable. This network permits measurements in high-impedance circuits, such as those found in TV-sync-separator and video-amplifier stages, which would not operate properly if loaded down by a conventional probe and cable.

When the probe is used in its low-capacitance position, the input capacitance of the instrument is reduced to approximately 11 $\mu\mu$f and the input resistance is raised to 11 megohms. (See Figure 4.) This high input resistance attenuates the signal by a factor of ten. Therefore, the

indicated voltage should be multiplied by 10 to obtain the actual value.

Adjustment of the WG-300A

The WG-300A is provided with a trimmer capacitor to permit adjustment of the square-wave response. The adjustment procedure is as follows:

1. With the WG-300A connected to the vertical input terminal of the oscilloscope, set the probe switch to "LOW CAP".

2. Obtain a trace of a clean horizontal-sync pulse from a television receiver by connecting the oscilloscope across the second detector load. A square-wave generator set to 1000 cps may be used instead of the sync pulse.

3. Loosen the threaded nut on the tip of the probe. Slowly rotate the probe tip for the best square-wave pattern on the oscilloscope screen. Tighten the nut.

NOTE: On WO-78A oscilloscopes it may be necessary to add a small trimmer capacitor (3-12 μμf) inside the instrument to compensate for the effects of the WG-300A Probe and Cable. Connect the trimmer from the V INPUT terminal to the nearest ground point. The capacitor should be added to all WO-56A oscilloscopes.

WG-302A RF-IF-VF Signal-Tracing Probe

The WG-302A RF-IF-VF Signal-Tracing Probe is a slip-on accessory for use with the WG-300A and WG-300B for signal tracing. The accessory probe contains a crystal diode and an rf filter housed in a plastic case. When the WG-302A is used, the switch on the WG-300 should be set to the "Direct" position.

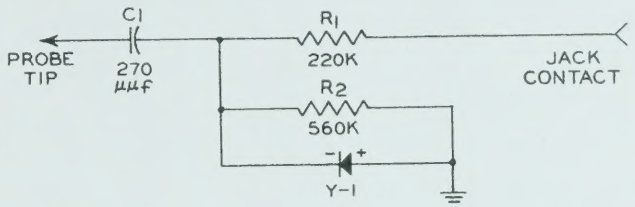

Figure 5. Schematic Diagram of WG-302A.

The time-constant of the rectifier circuit in such that when the WG-302A is used in high-frequency circuits, the low-frequency modulation is separated from the amplitude-modulated rf carrier. The low-frequency component is then fed to the input of the oscilloscope through the WG-300A or WG-300B. The waveform is centered vertically on the zero axis of the screen when an ac RC-coupled oscilloscope is used. When a direct-coupled oscilloscope is used, the waveform is displaced vertically a distance proportional to the dc voltage resulting from the rectification of the rf carrier.

When the WG-302A is used with an oscilloscope such as the WO-91A and a sweep generator is employed to sweep the picture or sound if amplifier of a television receiver, it is possible to observe the response characteristic of individual amplifier stages without upsetting the performance of the high-frequency stage. With this combination of equipment, it is possible to observe the re-

SPECIFICATIONS

	WG-299A WG-299B WG-299C WG-299D *(For use with models WV-77A, WV-77B, WV-77C, WV-87A#, WV-87B, WV-97A#, WV-98A, 195 and 195A VoltOhmysts and models 170 and 170A Chanalysts and similar instruments.)*		WG-300A WG-300B *(For use with models WO-56A, WO-78A, WO-78B, WO-88A, WO-91A, and similar oscilloscopes.)*		WG-301A *(For use with WG-299A, WG-299B, and WG-299C probes and cables.)*	WG-302A *(For use with WG-300A and WG-300B probes and cables.)*
	"DC" OPERATION	"AC-OHMS" OPERATION	"DIRECT" OPERATION	"LOW CAP" OPERATION		
INPUT FREQUENCY RESPONSE RANGE	*	30 cps to 3 Mc across 100-ohm source	*	Flat to 10 Mc (Probe and cable only)	±0.75 db 50 Kc to 250 Mc	±1 db 100 Kc to 250 Mc
INPUT RESISTANCE	11 megohms total with VoltOhmyst)	Depends upon VoltOhmyst	1 megohm (Scope Input Resistance)	10 megohm (with 'scope)	*	*
INPUT CAPACITANCE	Less than 4 μμf	Depends upon VoltOhmyst	Less than 100 μμf	Less than 13 μμf	Less than 3 μμf	Less than 3.75 μμf
MAXIMUM INPUT VOLTAGE DC	1500V	Combined dc and ac peak = 2000V	600V	600V	250V	250V
MAXIMUM INPUT VOLTAGE AC	1000V rms	1500V rms (sine wave)	600V peak-to-peak	600V peak-to-peak	20V rms	20V rms
DEMODULATION RANGE	*	*	*	*	*	30 to 2000 cps

* Does not apply

\# Has separate ohms cable. WG-299 used only for AC & DC functions.

sponse curves of picture and sound if amplifiers, video amplifiers, tuners, and overall response curves in all high-frequency sections of the television receiver.

An input capacitance of only 3 $\mu\mu f$ for the probe permits its use in these critical circuits and without seriously detuning the amplifiers. Because the capacitance of the WG-302A is less than that of the kinescope grid circuit, the probe may also be connected to the output of the video amplifier with negligible effect on the circuit.

The WG-302A extends the range of the oscilloscope of 50 Mc. This range covers the if and video frequency sections of television receivers. The connection of a short ground lead between the probe and the low side of the circuit under test will extend the usable range of 250 Mc for signal tracing in tuners. To add the ground lead, remove the nylon screw in the body of the case, and connect a 3-inch ground lead by means of a metal screw. Insulate the screw head.

The WG-302A RF-IF-VF Signal-Tracing Probe is designed to be used as an indicating device rather than a voltage-measuring instrument. If the WG-302A is used for voltage measurments, the probe and the oscilloscope can be calibrated against a known voltage.

Replacement Parts Lists

When ordering replacement parts, include the stock number and description of the part, as well as the type number of the probe. Parts should be ordered through a local RCA tube and parts distributor.

SYMBOL No.	DESCRIPTION	STOCK No.
	WG-299A DC/AC Ohms Probe and Cable	
	Probe sub-assembly - Consisting of the following parts: - Probe shell, shield, bushing and insulator, probe tip, switch and 1 megohm resistor....	211400
	Bushing - Probe tip bushing.....	210196
	Shell - Front molding.....	210195
	Shell - Rear molding, blue.....	210202
	Spring : Probe tip bushing tension spring.....	210197
	Connector - Cable, female.....	203574
	Connector - Cable internal connector..	210190
	WG-299B DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing.....	212161
	Connector: internal, brass for cable...	210190-A
	Connector, cable: female, with set screw.....	203574
	Shell: front end, blue.....	210195
	Shell: middle section, with shield, bushing, and insulator.....	212159
	Shell: rear section, blue.....	210202-A
	Spring, coil: for front end.....	210197
	Spring, switch: with insulator.....	212162
	Tip, probe: with switch slide and 1-meg. resistor.....	212160
	Washer, tip:.....	212163
	WG-299C DC/AC-Ohms Probe and Cable	
	Bushing, tip: for front housing.....	213257
	Connector: internal, brass, for cable.	210190-A
	Connector, cable: female with set screw.....	203574
	Shell: front end, blue.....	210195-A
	Shell: middle section, with shield, bushing, and insulator.....	213664
	Shell: rear section, blue.....	210202-A
	Spring, coil: for front end.....	210197
	Spring, switch: with insulator.....	213665
	Tip, probe; with switch slide and 1-meg. resistor.....	212160
	Washer, tip:	213271
	WG-299D DC/AC-OHMS probe and cable sealed unit, cannot be disassembled.	
	WG-300A Direct/Low-Capacitance Probe and Cable	
	Bushing: for probe tip.....	210196
	Clip: alligator clip.....	210207
	Connector: probe cable internal connector (rear).....	210201
	Insulator: alligator clip cover.....	210209
	Insulator: probe insulator and bushing with Buss wire and lug terminal.....	211691
	Ring: probe ground ring.....	210205
	Shell: center, includes 2 shields, bushing and insulator.....	211688
	Shell: probe, tip molding, blue.....	210195
	Shell: probe, end molding, blue.....	210202
	Spring: guard spring for cable.....	210208
	Spring: for probe tip.....	210197
	Switch: probe switch slide and spring.	211690
	Tip: probe tip and resistor.....	211689
	WG-300B Direct/Low-Capacitance Probe and Cable	
	Bushing, probe tip: for front end.....	213257
	Clip: for grounding lead.....	210207
	Connector, cable: internal, brass.....	213260
	Connector, cable: female, with set screw	203574
	Insulator, clip.....	210209
	Ring, ground: for center section.....	213262
	Shell: for front section, polystyrene, blue.....	212161
	Shell: for center section, polystyrene, blue, with bushing, insulator, and two shields.....	213256
	Shell: for rear section, polystrene, blue.....	213261
	Spring; coil: for front end.....	210197
	Spring, switch: with insulation and insulator.....	213259
	Tip: silver plated, with switch slide, 1-meg resistor, and capacitor....	213258
	Washer: for probe tip.....	213271
	WG-301A Crystal-Diode Probe	
C1	Capacitor: silver mica 500 $\mu\mu f$ ± 5%...	95503
R1	Resistor: carbon film, 4.7 meg. ± 1%, 1/2 w.....	213362
Y1	Crystal: crystal diode.....	54374
	Clip: alligator clip.....	210207
	Insulator & Jack Contact Assembly.....	211374
	Lead: unshielded, black, with alligator clip and terminal.....	211379
	Nut: clip lead nut.....	211378
	Screw: clip lead screw.....	211377
	Shell: probe housing blue.....	211372
	Spring: probe contact spring.....	211373
	Tip: probe.....	211375
	WG-302A RF-IF-VF Signal-Tracing Probe	
C1	Capacitor: silver mica, 270 $\mu\mu f$ ± 10%.	95504
R1	Resistor: composition, 220,000 ohm ± 10%, 1/2 w.....	502422
R2	Resistor: composition, 560,000 ohm ± 10%, 1/2 w.....	502456
Y1	Crystal: crystal diode.....	54374
	Clip: alligator clip.....	210207
	Insulator & Jack Contact Assembly.....	211374
	Lead: unshielded, black, with alligator clip and terminal.....	211379
	Nut: clip lead nut.....	211378
	Screw: clip lead screw.....	211377
	Shell: probe housing vlue.....	211380
	Spring: probe contact spring.....	211373
	Tip: probe.....	211375